FINAL REPORT OF THE 1985 AND 1986 FIELD SEASON AT HEAD-SMASHED-IN BUFFALO JUMP ALBERTA

Jack Brink and Bob Dawe

ARCHAEOLOGICAL
SURVEY
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ALBERTA
Manuscript Series
No. 16
1989

Alberta
CULTURE AND MULTICULTURALISM

FINAL REPORT OF THE 1985 AND 1986 FIELD SEASONS AT HEAD-SMASHED-IN BUFFALO JUMP, ALBERTA

By

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MANUSCRIPT SERIES
NO. 16

ALBERTA CULTURE
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1989

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FIELD SEASON AT HEAD-SMASHED-IN BUFFALO JUMP, ALBERTA

JACK BRINK
BOB DAWE

ARCHAEOLOGICAL SURVEY OF ALBERTA

July 1989 Edmonton, Alberta

ACKNOWLEDGEMENTS

We have been assisted by many people throughout the long haul of moving from excavation to final report. First, we would like to thank our field crew members from the 1985 and 1986 field seasons: Beth Mann, Marlyn Welk, Susan Marshall, Caroline Hudecek, Cory Holland, John Holloway, Maureen Rollans, Lydia Scott, Hazel Big Smoke and Mike Stefureak. Also, Milt Wright of the Archaeological Survey of Alberta was a senior member of our research team at the time of the field work, and we thank him for his assistance and the good times. We benefitted from the assistance of many volunteers; we cannot name them all, but we would be remiss not to mention the continuing help of Armin and Gerry Dyck of Coaldale, Alberta. Gerry, after four seasons volunteering with us, is certainly the reigning world champion in counting and weighing fire-broken rock. Two other volunteers who have withstood the test of time and returned for several seasons are Liz Bryan of Rock Creek, British Columbia and Claude May of Hardisty, Alberta. Many thanks to all.

As our crews have become something of a regular feature on the landscape of southwestern Alberta, we have come to benefit from the friendship, hospitality and knowledge of many of the ranchers and farmers who inhabit the Porcupine Hills. We thank the Calderwood family of Granum for their encouragement of our project and for continued permission to inspect and work on lands which they own. The Dersch family of Fort Macleod continues to keep their door open to our crews for beer, barbecues, looking at arrowheads, and talking about the history of the land and the people around the buffalo jump. We have learned much from Harvey, Colette and Rose Dersch and thank them for the hospitality which is deservedly famous in cattle ranching country.

In the lab, we have been assisted over the years by many workers who have shared the agony of trying to identify bison bones that pour through your fingers and squinting at lithic debitage that hides behind pin heads. Our thanks especially to John Albanese, George Chalut, Beth Mann, Guy Trott, Marlyn Welk, Sue West, Mike Fitzpatrick, Jeff Bailey, Kim Schultz, Rob Hastings and little Erna Reyes. Jean Wright of Edmonton examined the faunal materials for cut marks and green bone fractures, as well as sexing of limb bone elements. Brian Kooyman, Department of Archaeology,

University of Calgary, assisted with the experimental analysis of modern bison anatomy, as did Guy Trott and Sue West, both of Edmonton. Marc Cattet, Department of Zoology, University of Alberta conducted the fatty acid extraction from modern bison bones.

Additional support with the production of this manuscript came from our ace draftsperson, Wendy Johnson, from the all-powerful secretary, Diane Luther, and from our expediter of every miscellaneous thing under the sun, Karie Hardie. Martina Purdon, our editor, took the best we could do and, as always, made it better. Thanks to all you folks.

Continued support of ongoing research at Head-Smashed-In, and encouragement with all aspects of the project, consistently has been provided by Dr. Bill Byrne, Assistant Deputy Minister, Department of Culture and Multiculturalism, Dr. Jack Ives, Director, Archaeological Survey of Alberta, and Dr. Martin Magne, Assistant Director, Research, Archaeological Survey of Alberta. We thank all the other research archaeologists at the Survey who have continued to supply advise and criticism over the years. Bruce Ball, Martin Magne and Rod Vickers have been especially helpful with discussion or consultation on certain matters which appear in this manuscript. However, the many flaws which undoubtedly lie within the following pages are solely our own.

Publication of this report was assisted by a grant from the Friends of Head-Smashed-In Buffalo Jump Society. The authors gratefully acknowledge the support of this organization.

The cover illustration, by Judith Nickol of Coaldale, Alberta, is from a drawing on dispaly at the Head-Smashed-In Buffalo Jump Interpretive Centre.

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CHAPTER 1

INTRODUCTION

Archaeological field work at Head-Smashed-In Buffalo Jump (HSI) continued in the summers of 1985 and 1986. Field studies were conducted by staff of the Archaeological Survey of Alberta as part of the ongoing research associated with the development of a public interpretation facility at this site. During the two previous field seasons, 1983 and 1984, archaeological attention was focussed on the regions of the site complex which were to be disturbed by construction of the various facilities associated with the interpretive centre (Brink *et al.* 1985, 1986). By the time the 1985 field season began, the investigation of these areas was essentially complete. As a result, the focus for continued field studies shifted to the pursuit of a number of research problems. All research studies revolved around the central goal of exploring aspects of the site which were poorly or incompletely understood. Advances in these areas were considered essential for the production of the interpretive programme. This report will present the results of all studies conducted in 1985 and 1986. Preliminary reports on these results have already appeared (Brink *et al.* 1987; Wright and Brink 1986).

Because the primary project of the 1985/86 seasons consisted of two contiguous excavation units, it was deemed appropriate to report on the results of these excavations in a single, comprehensive report. This will be the third in a series of final reports of archaeological work at HSI; therefore, no attempt will be made to detail certain aspects of the project, namely, previous research at HSI, the site environment, and other matters which have been discussed previously (see Brink *et al.* 1985, 1986). To help set the scene for the following report, however, a brief summary will be presented.

Head-Smashed-In Buffalo Jump is located in southwestern Alberta at the southern end of the Porcupine Hills (Figure 1). Bison were rounded up in the confines of a large, natural basin located to the west of the jump and herded through a complex series of drive lanes to the edge of a 10 m high sandstone cliff. Topple and slump from the cliff face have formed a bench at the base of the cliff, and it is this bench that contains the stratified

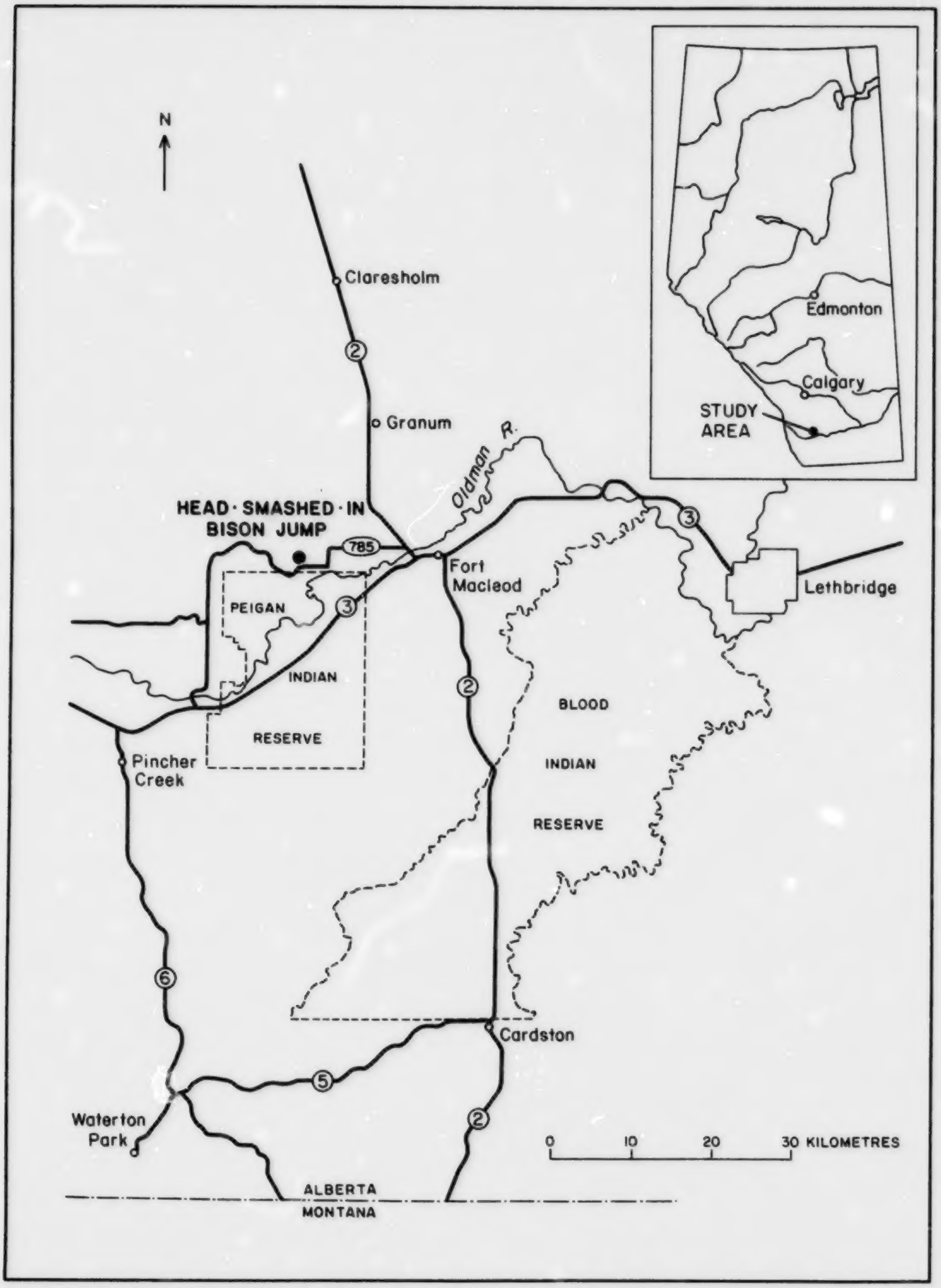


Figure 1. Study area and location of Head-Smashed-In Buffalo Jump, DkPj-1.

layers of bison bones and stone tools which extend to a depth of 11 m below surface (Figure 2). Archaeological study of the bone bed at the kill site has been conducted by Wettlaufer (1949) and Reeves (1978, 1983a). To the east of the kill, the bench drops off steeply to the prairie level, where a shallowly buried blanket of cultural material covers an estimated area of 500,000 square metres. This has been referred to as the processing/camp site portion of the site and has been the primary focus of recent site studies sponsored by the Department of Alberta Culture and Multiculturalism (Figure 2).

The rationale for the selection of this component of the site for detailed investigation lies, in general, in the paucity of archaeological examination of butchering/processing sites associated with communal bison kills on the Plains and, more specifically, in the fact that little was known about this component at HSI. When the Alberta government decided to construct a major, on-site interpretive facility, it became apparent that adequate development of the interpretive story line and displays required a substantial amount of new research into poorly understood aspects of HSI. The 1985 and 1986 field seasons saw a continuation of research at the processing/camp site portion of the site.

During the first season at HSI (1983), a number of exploratory excavations were placed over a large area of the processing site (Brink *et al.* 1985). This provided a preliminary indication of the nature and extent of cultural materials in different portions of the site. The following year, detailed excavations were conducted at the north end of the processing site, in an area some distance from the most heavily used part of the site (Brink *et al.* 1986). In selecting this area, we had hoped to avoid some of the confusion of the core area of the site where several thousands of years of bison processing are compressed into an unstratified soil averaging 15 cm in thickness.

The major thrust of the 1985 season was the excavation of four contiguous 2 x 2 m units at the south end of the core area of the processing site, approximately 350 m distant from the 1984 excavations. These excavations were designed to explore a portion of the prairie where a well trench had exposed cultural deposits extending to a depth (50 cm) more than twice what we had previously encountered (Wright and Brink 1986). Unfortunately, that year the units were placed on the very edge of the area

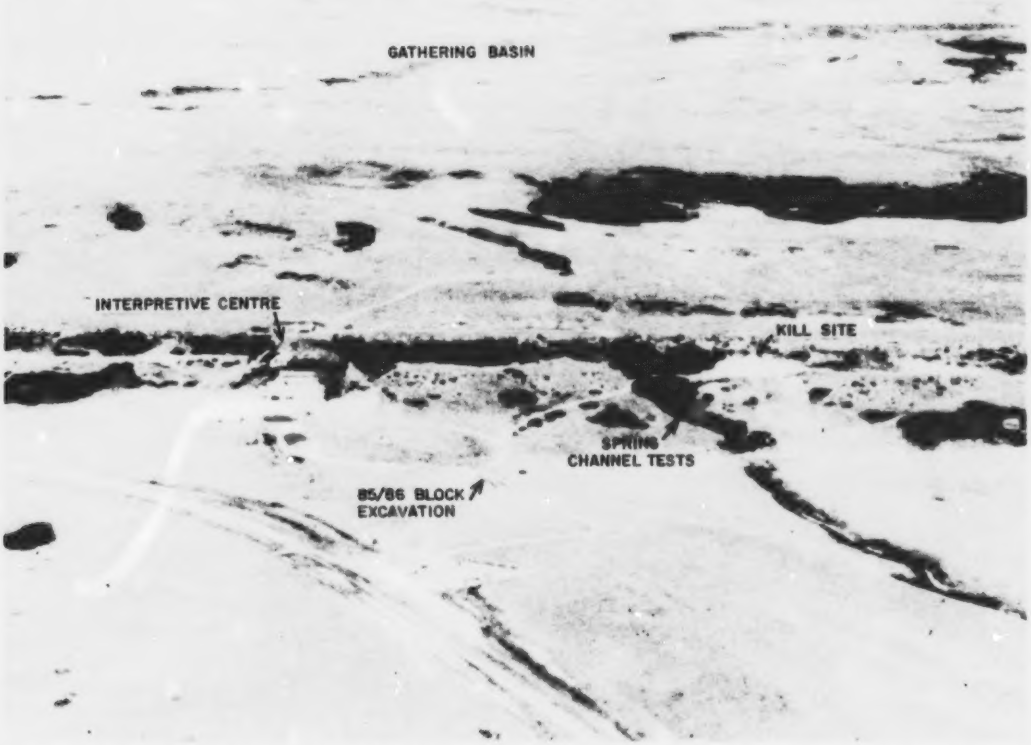


Figure 2. Aerial view of HSI site area showing kill and processing area locations.

of greater deposition, and only a thin strip of our excavations intersected the deeper cultural layers. Continued excavation in this locale was deemed advisable because this area offered at least limited potential to produce some vertical separation of temporally distinct occupations on the site.

Accordingly, we returned to this area in 1986. Two more 2 x 2 m units were placed directly adjacent to those excavated in 1985, along the west edge of the previous units where the deeper cultural materials had been encountered. This time we were successful in excavating entirely within the anomalous sedimentary basin where artifacts extend from the surface to c. 45 cm below surface.

The 1986 field season at Head-Smashed-In was small scale, relative to previous years, but was rewarding in that an 8 square metre area was excavated in a unique portion of the processing site. The increased deposition within the small sediment trap has produced a stratification of cultural materials which was not evident in other areas on the prairie. While it is true that this layering spans only 45 cm of soil, within which several thousands of years of butchering activities are compressed, and that rodent disturbance, as well as mixing of deposits caused by repeated re-use of the site (especially the excavation and re-use of features), likely have blended together numerous separate archaeological deposits, the situation is still markedly improved from previous years' findings and presents an opportunity to compare and contrast assemblage components recovered from a stratified sequence.

The majority of this final report will be devoted to a detailed presentation of the results of the two contiguous excavations in the processing area. Other, more minor projects were undertaken, and these too will be discussed. These include a brief test of the wet deposits located in the spring channel at the base of the kill site and a test screening of disturbed soil that had been bulldozed many years ago to form a dam across the spring channel.

In 1985, Maureen Rollans continued her work on the drive lane cairns at HSI. This work, conducted under her own research permit, has resulted in a report and her Master's thesis (Rollans 1986, 1987) and is not discussed further in this report. In addition, this report does not cover the results of the excavations conducted at the Calderwood Jump (DkPj-27). This jump, located about 1 km north of HSI, was visited and tested in 1985 and then more fully excavated in 1986. The initial testing has already been reported (Brink *et al*. 1987; Marshall and Brink 1986), and the subsequent excavations likewise were performed by Marshall as a thesis project under her own research permit.

REPORT CONTENTS AND ORGANIZATION

The following chapter of this report will present a review of the excavations: the number and placement of the units, the total area of excavation, and the methods of recovery and analysis. For the most part, our methodology differs little from that employed in the 1983 and 1984 seasons; however, some changes inevitably occur as more is learned about the site and its archaeological contents.

The third chapter of this report will discuss the soils, stratigraphy and chronology of the 1985/86 excavations. Although soils have been mentioned briefly in previous reports, only in the 1985/86 seasons, with the detection of a stratified area of the processing site, has the topic acquired greater importance. Likewise, the dating of the cultural deposits achieves new relevance, due to the apparent temporal separation of materials spaced throughout the 50 cm cultural horizon. Hence, greater effort was made to date the approximate time periods, and events, contained within this horizon.

Chapter 4 will present the results of our excavation and analysis of the features encountered during excavation of the processing area. As in previous years, features continue to be a major component of our examination of bison processing, and it is clear from our widespread testing of the prairie below the jump that features occur in great number and with considerable variety.

Chapter 5 of the report will present the analysis of the fire-broken rock recovered from the processing area excavations. This material occurs across the site in massive amounts and consists primarily of imported and, hence, probably curated materials. Thus, it is of considerable importance to our understanding of the events which transpired at the site. While fire-broken rock is often accorded a low status in other archaeological analyses, we are of the opinion that this material holds valuable clues to the organization and operation of bison processing, at least at Head-Smashed-In.

Chapter 6 is devoted to analysis and interpretation of the faunal remains recovered from both the processing area and the spring channel excavations. Using NISP, MNE and MAU measures of quantification, the structure of a bison processing assemblage is presented. Clearly, the HSI assemblage from the prairie level is in a poor state of preservation. Accordingly, considerable attention is given to examining the taphonomy and differential preservation of the faunal material. The major focus of faunal interpretation rests on an examination of our materials in relation to the models of carcass utility first proposed by Binford (1978). Our data are juxtaposed to Binford's indices of economic utility. Furthermore, our own recent work with a small sample of contemporary bison carcasses has provided new data on the anatomy of bison. These data likewise are employed to help shed light on the utilization of bison faunal elements at a communal butcher/processing site. Finally, the faunal material from the HSI processing area, spring channel and kill site are compared and contrasted, both with each other and with a selection of other bison kill/butchery sites from the northern Plains.

Chapter 7 details the lithic artifacts recovered from the 1985/86 excavations. Artifact descriptions by major functional/technological classes are presented, as are detailed descriptions of the various raw material types recognized at HSI. Since the results of these two seasons' work have provided us with an opportunity to examine some degree of temporal separation of the artifacts, a major focus of the lithic analysis is an attempt to discern any changes in the lithic assemblage throughout the Late Prehistoric Period. Again following the example of our previous reports, we have provided considerable metric and non-metric detail of the lithic assemblage. This is done in the belief that major site reports can perform a service to the archaeological community by providing the kinds of data often needed for intersite comparisons - data often frustratingly absent from other site reports.

Chapter 8 reports on the ceramic and historical artifacts recovered from our excavations. Since these materials occur in small numbers at HSI, this section of the report is necessarily brief and essentially descriptive.

Chapter 9 presents a brief discussion of what we feel are some of the more important ideas and implications arising from the results of the 1985/86 field seasons.

CHAPTER 2

EXCAVATION AND METHODOLOGY

DESCRIPTION OF THE EXCAVATION AREAS

The complete inventory of archaeological research for the two field seasons consists of four separate areas of excavation, two of which are minor in extent and will be mentioned only briefly in this report. These latter projects include a single 1 x 2 m test (unit 48) of a suspected feature located at the far northern end of the processing area, close to the area where a contiguous block was excavated during the 1984 field season. In addition, we completed the final levels of a 2 x 2 m unit (no. 4) in the central part of the processing area. This unit was begun during the 1983 season and had to be left unfinished until 1985. In this report, descriptive reference is made to the faunal and lithic material recovered from the two small projects, but no other discussion is included.

The two substantive portions of the 1985/86 seasons consisted of the excavation of a contiguous block area of the camp/processing area, located on the prairie level to the southeast of the main kill site, and the test excavation of the deposits near the head of the spring channel that bisects both the HSI kill and processing areas. The location of all excavation areas relating to the 1985/86 seasons is shown in Figure 3.

The site of the contiguous excavation, referred to as the "block," is an area of 25 square metres. The number and configuration of the units is shown in Figure 4. The area chosen for our block excavations lies about 200 m downslope and to the southeast of the main kill site (Figure 5). This is an area of level prairie near the toe of the slope of the slump materials which extend upwards to the bedrock cliffs and the kill area. The ground surface in the region is a mixture of open patches of drifted sand and silt and sparse, clustered bunches of prairie grasses. Wind and water erosion have acted to maintain the sparse, open nature of the ground cover on the prairie surface. The ground surface is also noted for a nearly continuous cover of fragments of fire-broken rock and small, weathered chips of bison bone. The burrowing activity of the ample population of Richardson's ground squirrels, combined with the effects of wind and water erosion,

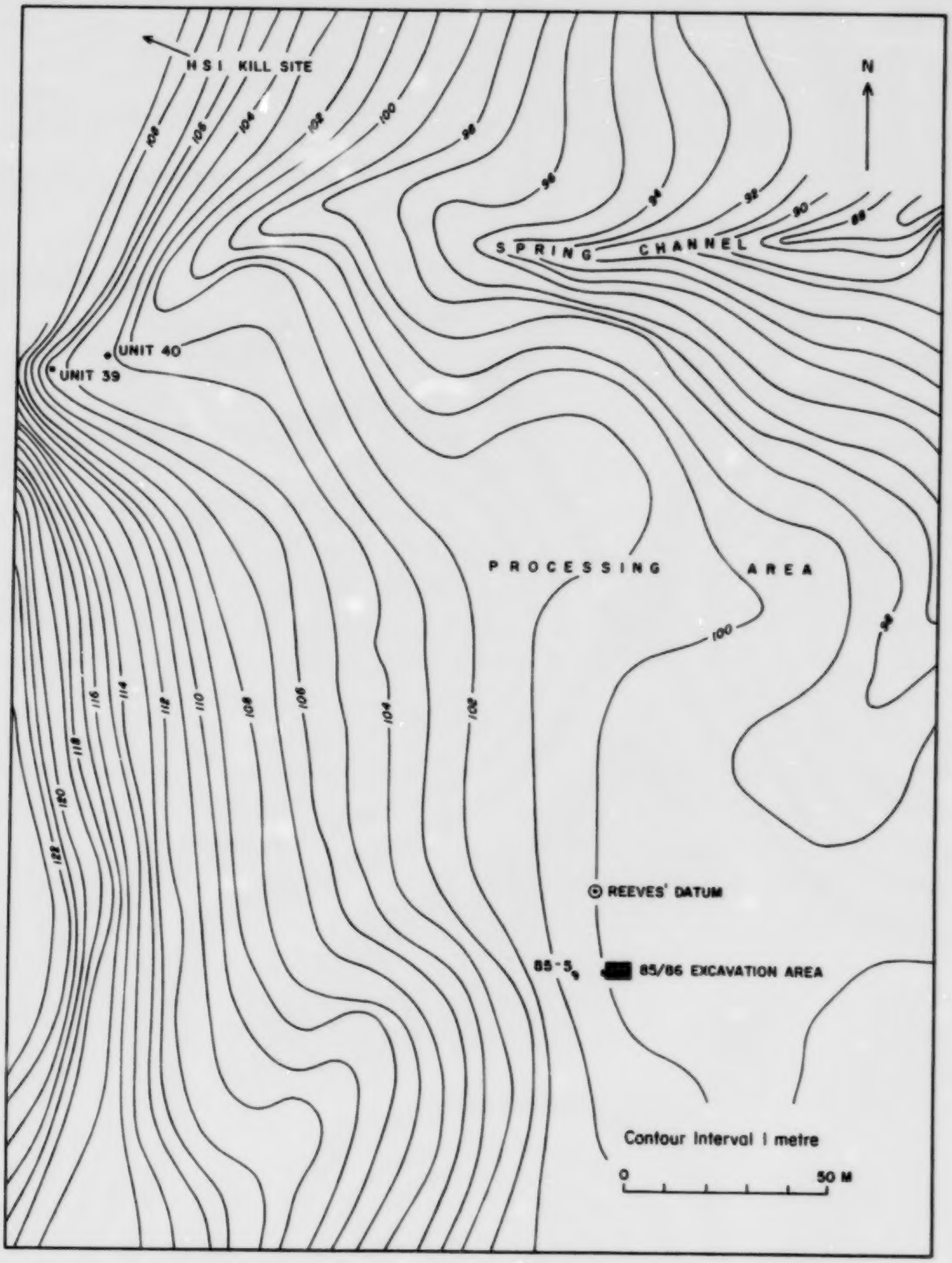


Figure 3. Contour map illustrating the camp/processing area and spring channel excavations.

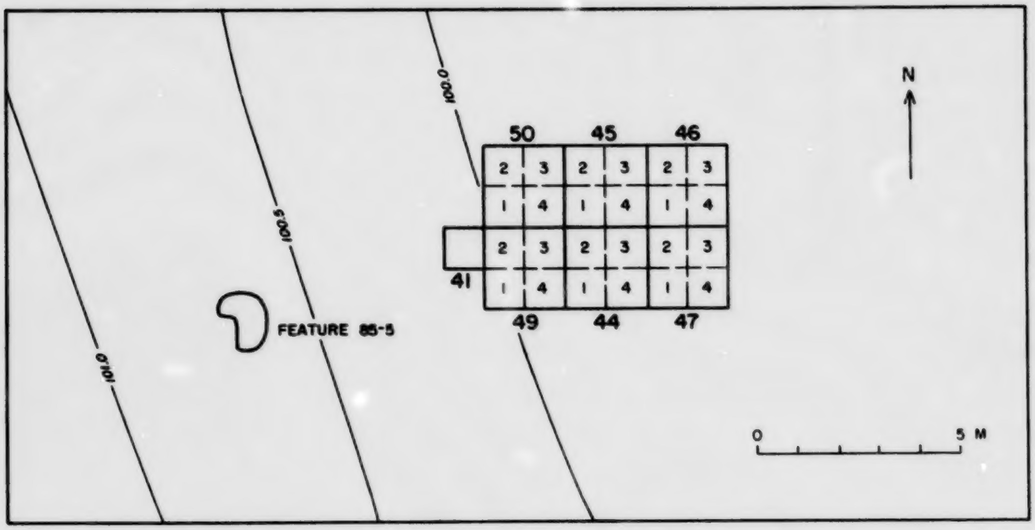


Figure 4. Plan drawing of the block excavation illustrating the excavation unit designations.

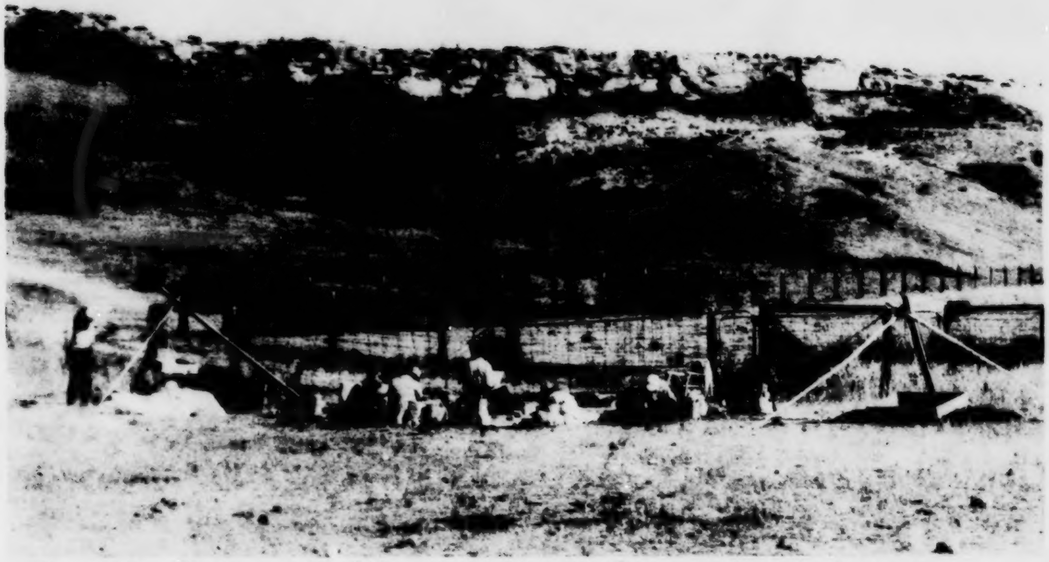


Figure 5. Photograph of the excavation in the camp/processing area looking northwest towards the spring channel and kill site.

have served to bring these materials to the surface. Our block excavation of this eroded prairie surface consisted of a rectangle, 4 x 6 m, with a single square metre added on to the western end of the rectangle (see Figure 4).

The rationale for the selection of this area for the primary excavations of the 1985/86 field seasons is tied directly to the nature of the soils and the depth of the cultural deposits contained within a small area of this region. By accident, the excavation of a well trench intended to supply water to the interpretive centre led us to an anomalous portion of the prairie where artifacts are buried to more than twice the depth we had encountered previously. These events, and the nature of the soils and stratigraphy of the region, are discussed in Chapter 3.

The prairie region surrounding the 1985/86 excavation area is characterized by cultural deposits extending no more than 20 cm below surface. In many places, such as the area of our 1984 block excavation, artifacts do not extend below a depth of 10 cm. However, the view afforded us by the excavation of the well trench confirmed the existence of deeper cultural deposits. Acting on this lead, in 1985 we placed a single 1 x 1 m unit (no. 41) a few metres to the east of the well exposure. Encouraging results then led to the placement of four contiguous 2 x 2 m units (nos. 44-47) approximately 2 m to the east of unit 41. It was anticipated that the deeper deposits evident in the well trench and in unit 41 would extend at least as far as the location of the four 2 x 2 m units. This proved not to be the case.

The four 2 x 2 m units excavated in 1985 straddled the edge of the small depositional basin where the deeper cultural materials were contained. We had placed the units too far to the east. The eastern end of the square revealed artifacts to the typical depth of about 20 cm, while the western end of the excavation, including two 1 x 1 m quadrants (nos. 1 and 2) of unit 45, revealed artifacts to a maximum depth of 45-50 cm below surface. As a result of this experience, we returned to the area in 1986 and added two additional 2 x 2 m units (nos. 49 and 50) onto the western end of the previous year's work. These units successfully intersected the small depositional basin, and artifacts within both units were recovered to depths of 50 cm.

Thus, the block excavation of the 1985/86 field seasons consisted of a area of 25 square metres. Of that total, 14 square metres fell outside of the area of deeper, stratified cultural deposits, and 11 square metres fell within the region of stratified soils. This area of 11 square metres, a subsample of the total block excavation, has been designated the "stratified block." The total volume of excavated area from the stratified region amounts to about 5.5 cubic metres or 61.1% of the entire block excavation. The non-stratified area of the block excavation, because of the shallow soils and cultural deposits, accounts for only 3.5 cubic metres or 38.9% of the total excavated volume of the block excavation area. Throughout the remainder of this report, the term "block area" refers to the entire 25 square metre contiguous excavation area, while the term "stratified block" refers only to that 11 square metre portion of the excavation area which contained deep, stratified materials.

The other substantive component of the 1985/86 seasons was a test of the deposits at the base of the kill site in the bottom of the channel of the spring which seeps from the sandstone bedrock. The aim of these tests was to assess the possibility that organic materials, such as wood and hide, might be preserved in the saturated soils of the channel bottom. Although the spring has flowed above ground rarely during the last decade, the spring has been very active in the past century and was dammed in the 1940s to provide water for cattle. In 1949, Boyd Wettlaufer and his archaeological crew swam in a pool formed in front of an earthen dam which had been built across the channel. Even today, running water is encountered in shallow excavations near the head of the channel, and it seems reasonable to suggest that the channel deposits have been saturated throughout much of the time the site was used.

The physical setting of the test excavations is nearly opposite that of the prairie. The channel is protected by steep slopes which are thickly vegetated with wild rose and Saskatoon berry bushes. The air in the channel head is still; there is little or no wind erosion of sediments here. Water, of course, continues to bring new sediments downslope and washes materials further down the channel. Sediments in the channel are deep, stratified and of both fluvial and colluvial origin. The stratification shows clear evidence of mixing, however, as recent bottle caps were recovered along side points belonging to the Mummy Cave complex. The excavations were conducted without any intent to ascertain temporal control, and provenience within the units was deemed to be irrelevant. Furthermore, testing of the channel was not envisioned as a sampling of the kill site fauna and lithic remains.

It was speculated that the enhanced deposition of the channel bottom, coupled with the saturated nature of the soils, might lend itself to the preservation of organic artifacts which may have been lost or abandoned at the kill site. The recovery of these, in 1985, was deemed important as they could augment the material culture items planned for display inside the proposed interpretive centre. Accordingly, two 1 x 1 m units (nos. 39 and 40) were placed near the head of the channel in an area where the channel begins to level off and where obvious bedrock topple was scarce. Further up channel, closer to the kill, the grade of the channel floor steepens markedly, and the rockfall becomes extreme enough so as to prohibit exploratory excavation. The upper unit (no. 39) encountered water at a depth of about 30 cm and was excavated to a final depth of about 1 m. The lower unit (no. 40; Figure 3) encountered water at about 1 m below surface and was excavated to a final depth of about 1.5 m. Thus, approximately 2.5 cubic metres of sediment was excavated from the units in the spring channel. As we had no facilities for wet screening, the saturated soils were passed by hand through a quarter inch mesh screen. This was not a very satisfactory recovery method, but it was considered adequate to meet our research goal of searching for perishable materials.

EXCAVATION METHODOLOGY

The methodologies for work conducted in the two main areas of research, the prairie and the spring channel, were decidedly different and will be discussed in turn.

Excavations at the Processing Area

It has been noted already that the contiguous units excavated on the prairie level in 1985/86 were placed so as to provide a sample of the relatively deep, cultural deposits observed in the profile of the well trench. Immediately to the west of the well head, the land surface begins to slope uphill towards the interpretive centre. Thus, the major area suitable for excavation lay to the east of the well. To provide a first glimpse of the subsurface deposits in this area an exploratory, 1 x 1 m test unit (no. 41) was placed a few metres to the east of the well head. The southeast corner of this pit is 200 m south and 2 m west of the datum used to establish the grid for our 1983 excavations (Brink *et al.* 1985).

Unit 41 was excavated by trowel in arbitrary 10 cm levels, and the contents of each level were screened through a one quarter inch mesh. The excavation of unit 41 differed from that of the remaining units in that none of the bone, lithic material, or fire-broken rock were mapped in place. Instead, all were recorded as to the 10 cm vertical level and 1 x 1 m unit of provenience. Since the mapping of artifacts within an isolated 1 x 1 m unit is of little interpretive use, we decided to postpone such precise provenience recording until after the results of this test excavation were known.

Upon completion of this exploratory unit, the square excavation area of four contiguous 2 x 2 m units was opened. The methodology employed for the excavation of this block area essentially was consistent with that used in the 1983 and 1984 seasons (Brink *et al.* 1985, 1986). The minimum unit of provenience was the 50 x 50 cm subquadrant. Excavation proceeded by arbitrary 10 cm levels measured from the surface. All matrix was screened through a one quarter inch (6.3 mm) mesh. Floor plan maps were drawn for every 10 cm level to record the distribution of identifiable bone, fire-broken rock (FBR) and features. As in 1984, all small bone scraps which were presumed to be bison but which could not be identified as to anatomical element were discarded in the backdirt. Bone fragments over 5 cm in any dimension which could be assigned to a general anatomical class, such as long bone or rib, were mapped and retained. All bones suspected of being non-bison were retained, regardless of their size or condition. Lithic artifacts were not mapped in place; rather, they were recorded as to the 50 x 50 cm unit and 10 cm level of provenience.

As discussed in the previous section, the placement of the 4 x 4 m block excavation in 1985 managed to intersect only a small portion of the localized depositional basin that contains the more deeply buried material. We attempted to rectify this situation in 1986 by returning to this area and placing two additional 2 x 2 m units (nos. 49 and 50) in the 2 m wide gap between the original test unit (no. 41) and the subsequent four 2 x 2 m units.

The excavation of unit 49 was conducted with the same methodology as used in the 1985 excavations described above. As it became clear that the stratigraphy was intact in this area, however, we decided to commence piece plotting of lithic artifacts in one half of our 1986 excavation area: unit 50. Due to the large number of lithic items present, and to the small size of most of these, we decided to limit the three-dimensional plotting to lithic artifacts measuring greater than 1 cm in length. Thus, exact horizontal and vertical provenience exists for lithic material from a single 2 x 2 m unit; for all other units, lithic artifacts were recorded as to the 50 x 50 cm horizontal and 10 cm vertical provenience.

Whenever features were encountered within the block excavation area, they were accorded separate status and were recorded on specially designed forms. Our standard procedure has been to excavate features in profile. Once the presence of a feature is confirmed, a string is placed along the longest axis, and one half of the feature is excavated. In the case of deep, rich pit features, the usual 10 cm arbitrary level provenience system is abandoned, and the feature matrix is removed in layers. Each layer consists of a cleared floor of bison bones and fire-broken rock which are mapped on the feature record forms and then removed. In general, each layer is usually less than a 10 cm level. The depth below surface of each layer of a feature is recorded. The soil matrix contained within each feature is retained in sample bags, again according to layers, and subsequently is floated or wet screened and picked.

The methodologies for the identification and classification of faunal and lithic materials, and for the processing of fire-broken rock, are described in subsequent chapters.

A minor part of our study of the archaeological record of the prairie included the testing of a suspected feature in 1985. The prairie north of the development area is pock-marked with a variety of depressions of unknown origin. To explore the possibility that some of these may be prehistoric features, we selected one such depression for test excavation. This depression, located near the site of our 1984 block excavation, was selected on the basis of its "suspicious" appearance and its proximity to other known prehistoric features. A 1 x 2 m trench, unit 48, was excavated with shovel and trowel to section the central, deepest part of this depression. Excavation of unit 48 was discontinued at a depth of 100 cm when it failed to reveal any indication of ever having served as a cultural feature. The few artifacts recovered were retained but not mapped in place.

In addition to the excavations described above, in 1985 we completed an excavation which we had been initiated two years earlier. This excavation, unit 4, had been terminated prior to completion of the second 10 cm level and had been capped with plastic and then backfilled (Brink *et al.* 1985:82). In 1985, this covering was removed, and the exposed floor was cleaned. The excavation then continued in a manner consistent with the methodology employed during the 1983 season. It became apparent that the bulk of the cultural material had already been recovered in the uppermost 20 cm, and the unit was essentially sterile at a depth of 30 cm below surface. At this point, a 1 x 1 m square within unit 4 was shovel shaved in 10 cm levels to a depth of 220 cm to check for the presence of deeply buried cultural material.

Screening of the Dam Fill

The final project on the prairie level was of a test screening of a sample of the earth which makes up the dam across the spring channel. This dam had been bulldozed across the spring channel to provide water for cattle. With the planned construction of the interpretive centre, it was decided to restore the site landscape to a more natural appearance by removing the dam fill. Because the fill consisted largely of soils and cultural materials washed down from the main kill site, we felt that there may be considerable value to the artifacts contained within the fill. Even though all the materials had been moved from their original location, the disturbed deposits likely would contain artifacts useful for display in the interpretive centre. Furthermore, it was from the surface of this earthen dam that Boyd Wettlaufer recovered two portions of projectile points identified as Alberta/Scottsbluff. The chance of recovering more early material, albeit disturbed, was another motive for examining a sample of the dam fill.

A total of approximately 25 cubic metres of earth was removed from the dam (an estimated 1% of the dam volume) with a backhoe and was subsequently passed through a one quarter inch mesh power screen. The amount and kind of material recovered were encouraging and led to a recommendation for complete removal and stockpiling of the remaining dam fill. This has since been completed, and the remainder of the fill may be screened in the future. After removal of the fill, the spring channel was landscaped to conform to its original shape.

Test Excavations in the Spring Channel

Four auger holes were used to help determine locations most suitable for excavation within the bottom of the channel. Subsequently, three 1 x 1 m test units were opened: units 39, 40 and 42. Unit 42 was terminated shortly after initiation, however. Excavation of these tests by arbitrary levels was accomplished with trowels and shovels, and the matrix was screened through a one quarter inch mesh. Screening of the matrix from these units was exceedingly difficult because of the wet nature of the soil. As it was, the methodology employed during the excavation of these three units was cursory and was designed to allow a quick estimation of the potential for recovery of highly perishable materials. No materials were mapped in place; rather, they were recorded as to the 1 x 1 m unit and 20 cm level of provenience. Further work in this area will require the use of water screening.

CHAPTER 3

SOILS, STRATIGRAPHY AND CHRONOLOGY

SOILS AND STRATIGRAPHY

Prior to the 1985/86 seasons, subsurface testing of the prairie level below the kill site had examined a wide ranging portion of the camp/processing site. Using the steep cliff of the primary kill site as a reference point, tests were conducted as far as 600 m to the southwest and 300 m to the northeast, as well as within what appears to be the heart or core of the processing site, just downslope and southeast of the main kill. These tests revealed that soil accumulation on the prairie level was minimal. The primary depositional mechanisms were almost certainly aeolian - wind-blown loess derived from areas to the west of the site - and to a lesser extent colluvial - slope wash sediments coming down from the slump blocks that fringe the exposed sandstone bedrock. If rates of soil deposition from these sources have ever been high, then processes of soil erosion likewise have been relatively active. This is clear from the recovery of diagnostic artifacts, and associated radiocarbon dates, which indicate that the last 2,000 years of site use are compressed into a maximum of 20 cm of soil. Indeed, in many areas of the camp/processing site, cultural deposits do not even extend below the upper 10 cm of the Ah horizon.

Wind and water are believed to be the primary agents of soil erosion as well. During our tenure at the site, we have often witnessed the removal of the poorly stabilized, silty top soil by the legendary winds which characteristically blow from the west. Likewise, the infrequent but dramatic summer downpours, which deposit more water than the soil can absorb, have been seen to wash top soil into the local drainage channels. This erosion helps to maintain the structure of the present grass community - principally rough fescue, western wheat grass and spear grass - in a thin, sparse and "bunched" pattern.

There can be little doubt that the prairie below the main kill site was used as a butchering/processing area during countless episodes of site use. The variety of temporally sensitive point styles, radiocarbon dates spanning the last 2,000 years, and the sheer bulk of the archaeological record which mantles this huge area are testimony to this fact. Yet soil erosion has prevented the stratigraphic separation of temporally discrete uses of the site and has resulted in a blended record of site use through time. As of the end of the 1984 season, the only exceptions to this situation were found in the channels of local springs. Here deposition rates were high, and stratification was well preserved, but cultural materials were largely redeposited (see Morlan 1985). The prairie itself seemed to offer little hope for the discovery of stratified cultural materials.

Although excavations at HSI in the mid-1960s included testing of the prairie level as well as the kill site deposits, little information on the former tests was contained in the published records (Reeves 1978, 1983a). While recent attempts to locate field notes of the prairie level excavations have proved unsuccessful (B. Reeves, R. Getty, personal communications 1983), several members of Reeves' field crew do remember some excavations on the prairie which yielded cultural materials from depths well in excess of the normal 20 cm range (W. Byrne, R. Getty, B. Reeves, personal communications 1983). The location of these excavations was said to be in an area of the prairie south and east of the main kill site, just alongside a fence line (now removed) that ran east-west across the prairie and upslope to the bedrock. Acting on this information in 1983, two 50 cm diameter shovel tests were placed on a north-south line extending towards this fence line (Brink *et al.* 1985:Figure 21). These tests failed to produce artifacts below the depth of c. 20 cm, and the issue was temporarily dropped.

Interest was rekindled in the summer of 1985 when excavation by backhoe of a well-head and associated trench provided an exposure which exhibited a thick Ah horizon and cultural materials extending to a depth of about 50 cm below surface. The well was drilled on the south side of the old fence line near the area of Reeves' prairie level excavations (see Figure 3). To confirm that this exposure extended beyond the well-head into an area where excavation would be possible, a 1 x 1 m unit (no. 41) was established a few metres east of the well-head excavation. Results of the excavation of unit 41 were encouraging, and the surrounding area was examined for a suitable location for a more ambitious excavation programme. A 4 x 4 m excavation area (units 44, 45, 46 and 47) was placed 2 metres to the east of unit 41 (see Figure 4).

Unfortunately, excavation of the four contiguous 2 x 2 m units revealed that the area of higher deposition with the thick (approximately 50 cm) Ah horizon was smaller than had been anticipated. Much of the major excavation area yielded artifacts to a depth of only c. 20-25 cm below surface, with no evidence of stratification or vertical separation. Only in the western edge of the units, closest to unit 41 and the well trench, did the Ah horizon and the burial of cultural materials dip to a depth of c. 45-50 cm below surface. Apparently, our units intersected the edge of what was presumably a small, sedimentary basin.

Visually, no depression that corresponds to the area of deeper sedimentation can be detected today. It can only be suggested that, in prehistoric times, a small, localized, natural topographic depression existed and that it served to collect and hold aeolian and colluvial sediments. Erosional forces would have been less effective in removal of sediment which collected in the basin. A brief inspection of the excavated units and the local topography by J. Dormaar (personal communication 1985) led him to concur with the postulated existence of a small depression. Aeolian deposition, as well as slope wash from the nearby rise which leads up to the sandstone bedrock cliffs, are presumed to be the sources of sediments which infilled this small, localized basin.

Regardless of what caused the pocket of deeper, organic, artifact-bearing soil, its existence offered the opportunity to recover cultural material with some element of temporal control, and, hence was the reason for the placement of the 1985 and 1986 excavation units. Because the 4 x 4 m area excavated in 1985 intercepted only a corner of the depression, in 1986, the two 2 x 2 m 1986 units were placed in the 2 metre gap between the 1 x 1 m test (unit 41) and the 4 x 4 m block excavation. This resulted in the excavation of 6 x 6 m contiguous area with a 1 x 1 m square placed on the west end of the block.

Soils within the excavation area are classed as a Rego Chernozem (see Figure 6). The sod layer is very thin, almost nonexistent in places due to the sparse grass cover. Below the sod is an Ah horizon which ranges in thickness from 30 to 40 cm. The Ah is a dark reddish-brown sandy silt with no visible structure, very low clay content and a few fine roots. The entire Ah layer is dense, with large and small fragments of fire-broken rock and bison bone. The bottom third of the Ah horizon, while still considered part

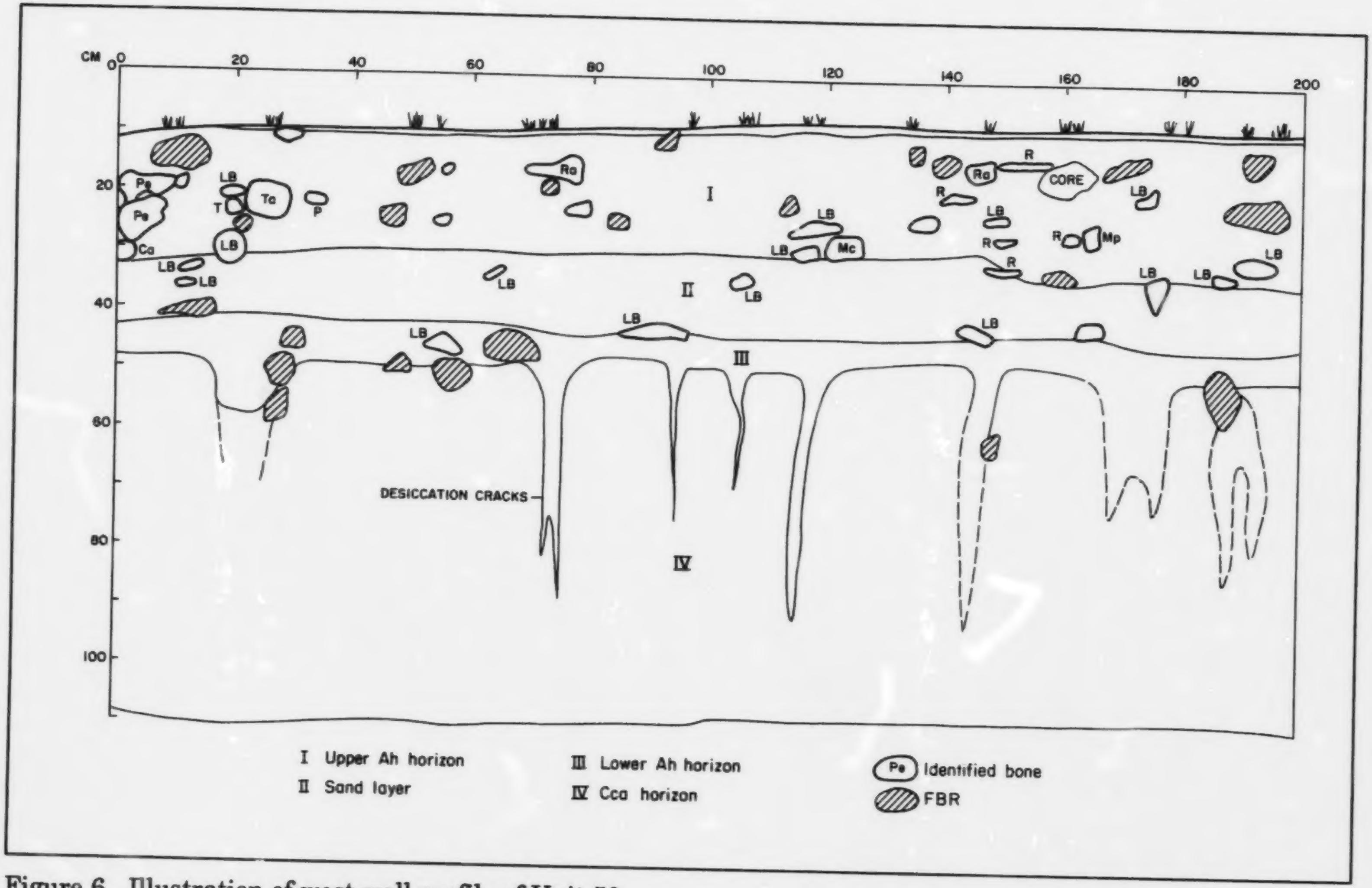


Figure 6. Illustration of west wall profile of Unit 50.

of this soil layer, is a distinct lens of dark, sandy soil about 10 cm in thickness. This layer is distinctive in that it exhibits a much higher sand content than the surrounding sandy silt, and it is largely, although not wholly, sterile of cultural material. The upper contact between the organic Ah horizon and the sand Ah lens is quite sharp and continuous throughout the western portions of the excavation area (Figure 7). To the east, the excavation units straddle the edge of the topographic depression, and here the Ah soil layer constricts towards the surface becoming no more than 20 cm in thickness. The sand lens likewise constricts over the boundary of the basin and eventually disappears. No trace of the lens could be detected in the eastern profiles of the excavation. It would appear that the sand lens is a sedimentary deposit confined to the bottom and side of the small depression area.

The sand lens which lies along the bottom of the Ah layer is a structureless, friable, silty sand with little or no clay content. Based on the high content of sand-sized particles in the lens, it is postulated that the origin of the deposit was colluvial rather than aeolian. Slope wash from the nearby talus slope is the most likely depositional agent. Although bone, fire-broken rock and natural sandstone fragments occur in abundance at both the upper and lower boundaries of the lens, very little cultural material is found actually within the deposit (see Figure 7). Of the few cultural items found in the sand deposits, some are clearly intrusive, as indicated by their placement within obvious ground squirrel burrows. A few items were recovered from the sand lens with no evidence of post-depositional disturbance, suggesting that some occupation of this portion of the site area occurred during the time the sand deposit was laid down. As will be discussed later, the age of this depositional event may be estimated to be approximately 1,100 years B.P., based on two bracketing radiocarbon dates. If, as suspected, the deposit originated from slope wash, rapid deposition during a period of increased rain or snow melt is entirely possible. The sand lens could have been laid down during a single year; therefore, a hiatus in the use of the processing area, while not ruled out, is not confirmed by the presence of the nearly sterile deposit.

The contact between the lower limit of the sand lens and the horizon below this layer is faint, diffuse and difficult to trace across the units. Below the sand, at a depth of about 30 cm below surface, there is a

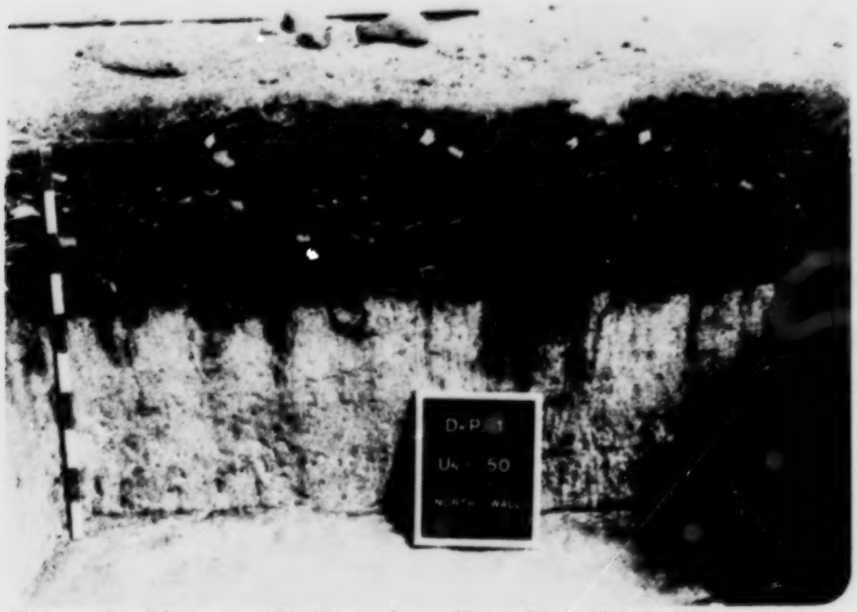


Figure 7. Photograph of north wall profile of Unit 50.

continuation of a dark reddish brown organic soil similar to the upper parts of the Ah horizon. This lower organic level may be a buried soil that was capped by the relatively rapid deposition of the sand layer. Subjectively, the sand content in the lower portions of the Ah horizon seemed lower than that of the overlying sand lens. The silt content was correspondingly higher; and there were increased amounts of clay. The most obvious characteristic of this soil horizon was the notable increase in culture material just below the sand lens. Fire-broken rock, bison bones and local sandstone occurred along the contact between the sand lens and the lower Ah horizon, although not in as high a frequency as was noted above the sand lens.

The lower Ah horizon averaged about 8 cm in thickness. Below this layer, at a depth of about 40 cm below surface, the contact occurred between the dark, organic, artifact-bearing soil and the lower, lighter brown, sterile, mineral soil. This lower horizon, which tests have shown extends for at least several metres below the surface, is a carbonate rich Cca horizon. This horizon is composed of very fine, clayey silt particles of aeolian origin. Clay content is markedly higher than in the overlying horizons and seems to increase with depth. A noteworthy feature of the Cca horizon was the presence of numerous desiccation cracks, originating at the top of the horizon and extending 50-60 cm into the clay layer. Also, as the horizontal excavation of this horizon commenced, the floors of the units exhibited a distinct polygonal pattern of cracking where darker, organic soil had penetrated into desiccation cracks. Cultural materials have intruded into the Cca horizon by means of falling into these desiccation cracks. Artifacts are also found in ancient burrows which penetrate into the parent material. Otherwise, this mineral soil is essentially sterile. However, every year that we have worked at HSI we have taken down a sample of excavation units well into the Cca horizon (c. 1-2 m below surface), and every year we recover slim yet enticing evidence of *in situ* cultural materials. For example, in 1983, one definite chert flake and a few tiny bone fragments were found at a depth of c. 90 cm in the Cca horizon, and the lower limbs of an articulated and apparently not butchered bison was recovered from 1.3 m below surface (Brink *et al.* 1985:45, 69). Most commonly, when pits are excavated through the Cca horizon, a few scraps of very heavily eroded bone are recovered from a context which cannot be explained by virtue of intrusion from desiccation cracks or burrows. The bone fragments, seldom more than a centimetre in any dimension, exhibit deep surface etching, presumably caused by carbonates. Nothing which remotely resembles a living floor has yet been found in the Cca horizon; however, since the deposition of this loess layer clearly spans a portion of the time during which the adjacent kill site was being used (c. pre-2,000 years B.P.), the few cultural items in the Cca horizon could be evidence of early use of the processing area.

CHRONOLOGY

Previous work at HSI by Reeves (1978, 1983a) has established the basic cultural sequence and associated radiocarbon ages for the use of the kill site. Reeves did not attempt to order the chronological history of the processing area, but work at the site by Archaeological Survey crews has attempted to address this issue. Recognizing that dates from bison bone recovered from a 10-15 cm thick, compressed and demonstrably mixed archaeological assemblage would be of little value, radiocarbon assays obtained during the 1983 and 1984 field seasons tended to be from hearth or pit features where some potential exists for dates which pertain to specific events in time. Dates obtained so far have ranged from a few hundred years to about 1,800 years B.P. (Brink *et al.* 1985, 1986).

The 1985/86 excavations in the portion of the processing area where sediment accumulation has resulted in at least minimal stratigraphic separation of cultural materials offer new potential for chronicling the prehistoric events of bison butchering and processing. For this reason, a fairly large number of radiocarbon dates were obtained, especially following the 1985 season. As before, dates were often run on pit features; however, dates were also obtained from stratified layers within excavation units. In addition, one date was obtained from bison bone collected from one of the units placed in the wet deposits within the spring channel.

Table 1 presents the results of the radiocarbon dates obtained from the 1985/86 field seasons. The first three dates illustrate the depositional history and cultural chronology of the sedimentary basin where the excavations took place. These dates are from arbitrary 10 cm levels (1, 3 and 5) in unit 41, which was the first 1 x 1 m unit placed within the depositional basin area. The dates from these three levels (360, 870 and 1,300 years B.P., respectively) are in proper stratigraphic sequence. They are also in keeping with expected ages based on diagnostic projectile points contained in the arbitrary levels in unit 41. All three dates were obtained from bison bone contained in the levels.

These dates allow a tentative assessment of sediment accumulation within the anomalous basin area. Based on the depth of the samples below surface, the average sedimentary rate from the 50 cm thick cultural deposit is 3.35 cm of deposition every 100 years. Of course, it is impossible to determine whether the rate of deposition has been relatively constant over this time period or episodic depositional events have laid down and/or removed large amounts of sediment in fairly short spaces of time. Given what we know of the environmental extremes that characterize this area, we suspect the latter.

As noted above, the sand lens buried within the Ah horizon could well have been deposited in a relatively short period of time. Whatever the case, the dates are encouraging in that they indicate that cultural materials from

Table 1. Radiocarbon dates from 1985/86 excavations at DkPj-1.

Lab # AECV	Unit	Feat	Level	Depth	Wt.(g)	Material	DATE YEARS B.P.	C-13
239	41		1	0-10	463.9	Bone	360±180	
238	41		3	20-30	797.8	Bone	870±90	
237	41		5	40-50	574.8	Bone	1300±70	
233	44	85-4	1	0-10	519.1	Bone	1030±150	
249	44	85-4	1	0-10	3.8	Charcoal, flotation	690±150	
232	44	85-4	3	20-30	435.4	Bone	1250±180	
248	44	85-4	3	20-30	2.5	Charcoal, flotation	410±130	
231	44	85-4	5	40-50	467.5	Bone	1280±100	
191	44	85-4	6	50-60	21.5	Charcoal, Flotation	1250±90	
250	44	85-4	6	50-60	3.7	Charcoal, flotation	680±120	
241	44	85-4	7	60-65	357.1	Bone	1080±90	
235		85-5	1	0-30	651.7	Bone	830±80	
234		85-5	2	30-40	579.9	Bone	1790±80	
247		85-5	3	40-50	7.2	Charcoal, flotation	1100±80	
374	50		2+3	18-25	429	Bone	800±90	-20
375	49/50		3+4	28-33	369.5	Bone	1360±140	-19
240	45		5	40-50	295.4	Bone	1620±80	
236	40		3	1-1.5m	383.3	Bone	1260±90	

different time periods are indeed spaced over some 50 cm of accumulated sediment. Clearly, there are numerous episodes of site use compressed into the Ah horizon, and the dated horizons do not represent single components. However, some discussion of site use through time can be attempted. This has not been possible for other locations we have excavated in the processing area of the site.

The next series of eight dates (Table 1) are from a single pit feature (85-4). Extensive dating of one feature was done in an attempt to gain some information on the sequence of use of the pit features that are so ubiquitous to the HSI processing area. As we have speculated before (Brink *et al.* 1986:40-93), some of the features discovered at HSI show evidence of having had a single function and a narrow time dimension, while others exhibit evidence of having been used repeatedly, possibly over a considerable period of time. Distinguishing between single and multiple use features is often difficult, however, and it was decided to attempt a range of dates from various levels of a single pit. In addition, the new radiocarbon lab at the Alberta Environmental Centre was interested in running paired samples of bone and charcoal in order to check the calibration of the new equipment. Accordingly, a series of four pairs of dates were obtained on bone and charcoal samples which had been recovered from within feature 85-4.

As can be seen from Table 1, there is considerable variation among the dates from a single pit. Dates range from 410 to 1,280 years B.P.; however, the more recent dates for this feature come from three charcoal samples (nos. 248, 249 and 250). (Note that all of these charcoal samples are quite small, with an average weight of only 3.33 g.) These dates suggest an age for the pit of between 400 and 700 years B.P. Without these three assays, the remaining five dates are more consistent, suggesting and age of about 1,100 radiocarbon years B.P. (Note that four of the dates which cluster around 1,100 years B.P. are from bone samples, while the remaining date [no. 191] is from a large sample of charcoal [21.5 g].)

The four dates obtained from bone show no particular orientation within the pit feature. In fact, the two youngest dates come from the very top and the very bottom of the feature. The bone dates from levels 3 and 5 are very similar. These two latter dates are also nearly identical to the oldest charcoal date (no. 191). This charcoal date was obtained on a substantial sample that was collected from a thick, black, greasy, charcoal-rich rind of earth lining the bottom of the pit. The context of sample 191 clearly suggests a positive link with the construction and use of the feature. In contrast, the other three charcoal samples, which yielded the younger dates, were all diffuse samples of small specks of charcoal collected through flotation of the dirt matrix. None of these appeared in the pit in a manner suggesting *in situ* burning. Rather, it is our opinion that the charcoal which produced the youngest dates had been redeposited in the pit subsequent to the completion of the original pit function. This likely would have resulted from deposition of wind-blown soil and charcoal settling between the large, angular bison bones. Also, burrowing rodents could have moved the fine charcoal through the soft pit fill.

We accept the single charcoal date of 1,250 years B.P. as likely correct. This date is in close agreement with all four bone dates recovered from throughout the depth of the pit. From this, we conclude that most or all of the faunal material was deposited in the pit at about the same time, approximately 1,100 to 1,200 years ago. This is not to say that the pit has not been reused. The original pit could have been constructed at an earlier date, subsequently cleaned out, and reused about 1,100 years ago. We can suggest, however, that the faunal contents which we recovered from the pit do not appear to have been deposited in the pit over a long period of time.

The next series of three dates from Table 1 are also from a large feature (85-5) excavated in 1985. As discussed elsewhere, this pit feature was also discovered in the excavation of a well trench, a few metres to the west of our 1985 excavations. The uppermost date, from level 1, was obtained from several large pieces of vertebrae recovered from about 25 cm below surface. For this feature only, the upper 30 cm of soil was removed as a single level to allow quick access to the top of the feature. The date of 830 years B.P. is quite consistent with the two other dates obtained from our block excavation from similar depths: 870 years B.P. from 20-30 cm deep in unit 41 (no. 238); and 800 years B.P. from 18-25 cm deep in unit 50 (no. 374). The similarity of dates from equivalent depths in the block excavation area is encouraging and leads us to suspect that the 30 cm thick Ah horizon, overlying what we believe to be the top of feature 85-5, is undisturbed soil and cultural material which has accumulated since the last use of the feature.

The two dates from 85-5 below the 30 cm depth (nos. 234 and 247) are more problematical. The charcoal date from 40-50 cm below surface is significantly younger than the bone date from one level above. Yet this does not seem to be a case where the charcoal is intrusive to the feature, as with 85-4. Indeed, sample 247 was collected from a thick lens of charcoal located in the bottom of the feature. We have no reason to discount the charcoal date. Similarly, the bone which produced the date of 1,790 years B.P. was collected from just above the rock slabs which lined the bottom of the pit and hence should relate to the use of the feature. Multiple pit usage is a likely explanation for these discrepancies.

The next series of three dates from Table 1 are again from the portion of the 1985/86 block excavation which exhibited the greatest depth of burial of cultural material, that is, units 49 and 50 from the 1986 season and an adjacent part of unit 45 from 1985. The first two dates (nos. 374 and 375) were selected specifically to provide the most accurate age estimate of the largely sterile, sand lens found throughout the western half of our block excavation. To achieve this, we collected bison bones from the west walls of units 49 and 50 after the completion of the excavations. A sample of bones (no. 374) was collected from the upper contact of the sand lens, and a second sample (no. 375) was gathered from the lower contact (see Figures 7 and 82). This allowed us to bracket the age of the sand lens with greater confidence than would be possible by simply selecting bones from arbitrary 10 cm levels.

The resulting dates of 800 and 1,360 years B.P. are entirely consistent with our expectations, based on the other dates obtained from the block excavation and on the association with temporally diagnostic projectile points. The dates compare favourably with those most directly comparable, the dates from levels 3 and 5 of unit 41 (i.e., 870 and 1,300 years B.P.). The dating of the bones extracted from the unit 49 and 50 profile indicate a 500 year interval during which the sand lens may have been deposited. Of course, we are no closer to knowing whether the sand layer was laid down gradually throughout this period or abruptly at some point during this interval.

The final date from the block excavation (no. 240) comes from the basal layer of unit 45 and was intended to provide another estimation of the oldest cultural material found in this area of the processing site. The date, 1,620 years B.P., is generally in line with our expectations. We might have anticipated a date closer to that of 1,300 years B.P. from level 5 in unit 41; however, the date of 1,790 years B.P. from feature 85-5 serves to indicate that materials dating to the early portion of the Late Prehistoric Period are found occasionally in this area of the site.

The last date from Table 1 is one obtained from the head of the spring channel below the kill site. As explained elsewhere, saturated deposits and well-preserved bone were encountered in unit 40. The stratigraphy was clearly mixed; historical items were recovered alongside artifacts that, on typological grounds, date to several thousand years before present. Nevertheless, it was decided to obtain one date from a sample of bone collected from between 1 and 1.5 m below surface. We are not presently in a position to evaluate the accuracy or implications of the resulting date of 1,260 years B.P. Additional work will be needed to illuminate the murky chronology of the slumped and redeposited sediments in the channel.

Perhaps the single most noteworthy result of the dating of the 1985/86 excavations at HSI is that none of the radiocarbon dates exceeds 1,800 years B.P. This is consistent with the findings of our previous seasons and raises intriguing questions about the use of the processing area by the Middle Prehistoric Period hunters who seem to be well represented in the deposits of the kill site (Reeves 1978, 1983a). After four years of research on the prairie level at HSI and testing of a widespread region, we have yet to discover more than the faintest evidence of use of the lower processing area by makers of point styles other than Avonlea and Old Woman's. The evidence collected to date consists of only a tiny number of points attributable to the Besant, Pelican Lake and Mummy Cave cultures, compared with literally hundreds from the later time periods. As yet, there are no radiocarbon dates from the prairie level which exceed the accepted range of Avonlea occupation.

Did the earlier cultures which used the jump not bring bison carcasses to the processing area? And, if not, did they butcher and process the animals immediately at the kill site? Or did they hardly butcher the animals at all, a pattern noted by Frison (1982) with regard to Palaeo-Indian bison kills. Or did they utilize a portion of the prairie which has still eluded us? While these questions currently cannot be answered, it seems safe to conclude that the massive processing area at HSI is primarily, and perhaps almost exclusively, a product of the Late Prehistoric Period. This may suggest a strong intensification of bison processing during this time period.

CHAPTER 4

FEATURES

INTRODUCTION AND METHODOLOGY

Features have been a common discovery at the Head-Smashed-In processing area since excavations began there in 1965 (Reeves 1978). Excavations sponsored by the Archaeological Survey of Alberta from 1983 to 1986 have added a significant number of bison processing features (Brink *et al.* 1985,1986). Indeed, as work continues, it may well prove that the documentation of a large number of features is one of the most significant contributions of the HSI project. In part, this is due to the facts that features tend to be synchronic events; they usually can be dated; and, because of the relatively rapid burial of pit features, they tend to offer the best preserved bone in the processing area. The importance of all of these factors is appreciated when one considers the diachronic, unstratified nature of the great bulk of the processing area.

Nine features were encountered during the 1985 and 1986 excavations at the processing site at Head-Smashed-In. These include eight features recovered during excavation of the contiguous block excavation (Figure 8), and one feature (85-5) exposed by heavy equipment during the excavation of a water service trench (Figure 9). Feature types represented include two multiple bone uprights (85-7 and 86-2), five pit features (85-3, 85-4, 85-5, 85-6 and 86-1) and two hearths (85-1 and 85-2).

Methods for the excavation of features differs little from the general excavation strategy. All identifiable bone, fire-broken rock over 5 cm in size, and all lithic artifacts were mapped in place. The only special attention paid to features was that the soil matrix from large pits and hearth stains was retained for subsequent fine screening and flotation.

For the purpose of the feature descriptions, the faunal material recovered within the features is summarized here using a standardized set of elements and element groupings. These faunal summaries have been based on the number of individual specimens (NISP) and include the following categories: skull, vertebrae, ribs, pelvis, scapula, upper front limb (humerus, radius and ulna), lower front limb (carpals and

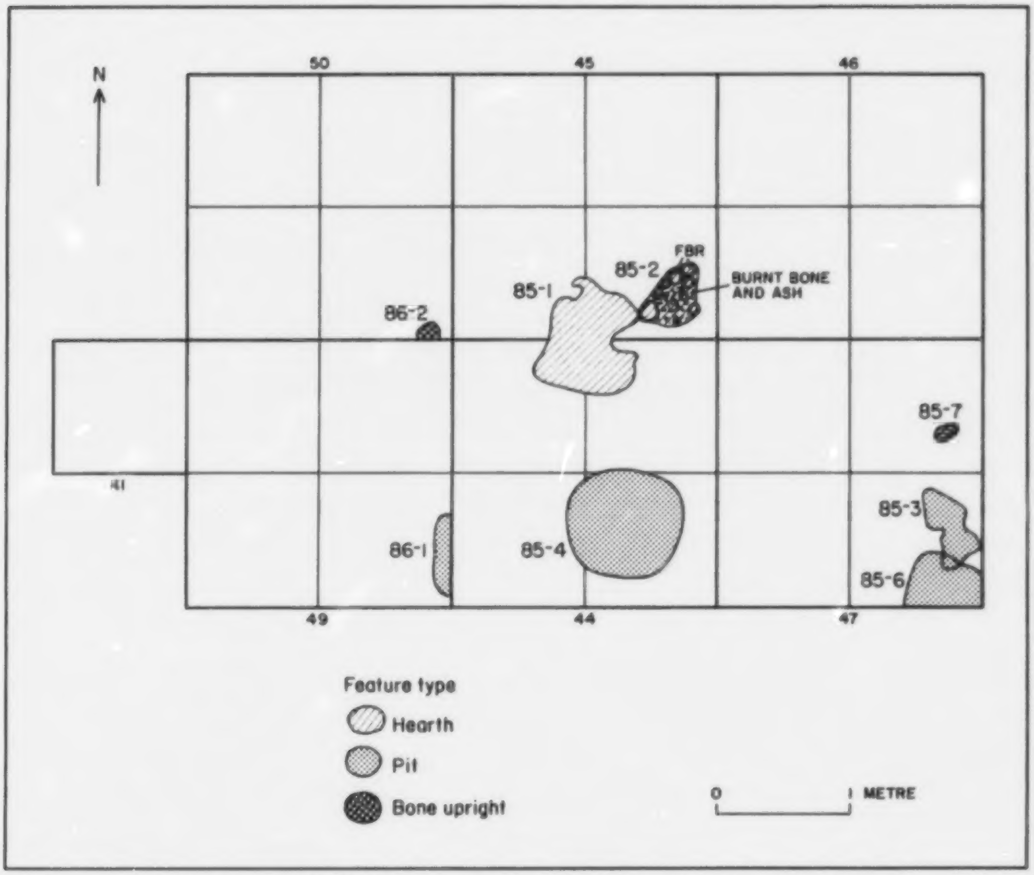


Figure 8. Plan map of block excavation showing the distribution of features.

metacarpal), upper rear limb (femur, patella and tibia), lower rear limb (tarsals and metatarsal), unidentified long bone fragments, sesamoids, unidentified metapodials and phalanges. Additional discussion of the faunal material recovered from features is provided in the chapter entitled "Faunal Remains."

FEATURE DESCRIPTIONS

Bone Uprights (n=2)

Although numerous instances of vertically oriented or slanting faunal elements were observed, such an orientation sometimes may be explained by fortuitous circumstance, as in cases where a bone has slipped into a rodent burrow and subsequently has been buried. Many such

Figure 9. Photograph of block excavation looking southwest towards the water service trench and interpretive centre construction. Note the well-head is at the extreme right end of the water service trench, behind the screen tripod.

instances were observed at HSI, as indicated by inclined bones contained within a clearly disturbed soil matrix. If there was any doubt that the faunal material so oriented was due to post-depositional factors, they were not considered features. The prime requirement for identification of a bone upright feature was the presence of sterile, undisturbed soil around the base of the inclined bones.

In two cases, a number of tightly grouped elements with a vertical orientation were considered to be deliberate arrangements. These two bone upright features were recovered in the contiguous block excavation (Figure 8). Both can be described as multiple bone upright features, consisting primarily of bison limb bones, oriented vertically, with the articular ends up. The soil around these bone uprights was an essentially sterile buff silt, free of other cultural material and devoid of evidence of rodent disturbance. The soil immediately adjacent to and between the faunal elements was a dark, organic, rich soil which contrasted with the surrounding lighter coloured soil, delimiting the extent of these features.

Feature 85-7

This feature is a tightly packed multiple bone upright (Figure 10). In plan view, the feature measures 12 x 15 cm. The top of the uppermost element occurred at a depth of 20 cm below surface, and the lowest extent was 45 cm deep. Faunal elements include two scapula fragments, a distal metacarpal, a distal radius and a proximal metatarsal (all *Bison bison*). The articular ends of the latter three bones are facing upward. The metacarpal exhibited a dent on one articular condyle, suggesting that it had been impacted, presumably to drive it rather than place it into the ground. The metatarsal was longitudinally shattered, although the pieces were held together by the surrounding bone elements and soil. This also suggests breakage due to being being hammered into the ground. The dark soil which demarcated the limit of the feature did not extend beyond the periphery of the bone, again indicating that the bones were driven into the ground rather than placed in an existing hole.

Feature 86-2

The principle elements of this bone upright are a pair of left distal bison tibiae. The tibiae shafts had been vertically pushed or driven down into a sterile, buff-coloured silt with the articular ends up (Figure 11). This bone upright extended from 23 to 45 cm below surface and measured 13 cm in maximum horizontal dimension. No clear evidence of battering was observed on the uppermost surfaces of the tibiae, but, if these elements were pounded into the ground when fresh, the astragali and navicular cuboids may have been articulated. Several of these latter elements were found nearby, although none was obviously associated with the elements in the upright feature.

In plan view, the two tibiae are adjacent but are turned at approximate right angles on the edge of the roughly, circular dark soil stain which marks the feature limit. It appears as if they had both originally backed on to a missing object that filled the space indicated by the soil stain. A fragmentary distal humerus was recovered from this latter area lying with the articular surface down in a position which suggests a fortuitous rather than primary association with the two tibiae. It may be that the humerus fell into a void left when an object, such as a post, had been removed from this feature.

Figure 10. Profile of multiple bone upright feature 85-7.

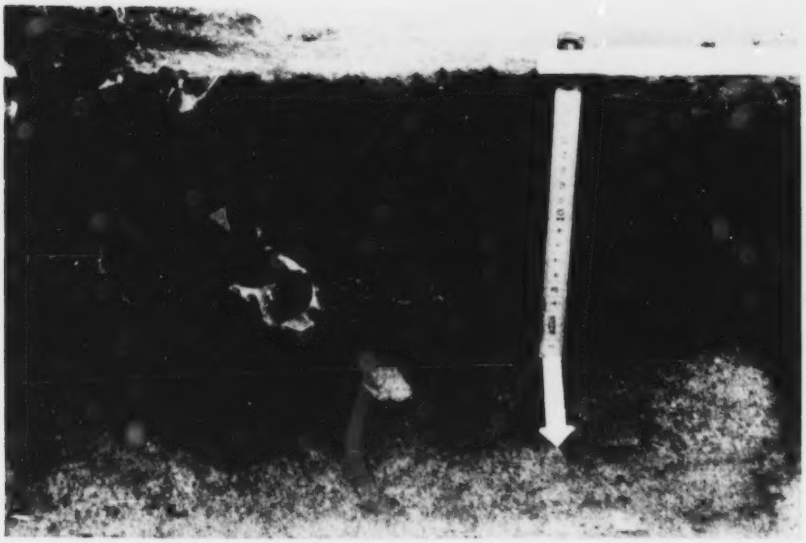


Figure 11. Profile of multiple bone upright feature 86-2.

Discussion

Bone upright features have been reported from an increasing number of Plains sites (Gruhn 1969; Kehoe 1967; Keyser 1979; Munson 1984; Neuman 1975; Quigg 1975), and several have been recovered from the Late Prehistoric assemblages from the processing area at HSI (Brink *et al.* 1986:62-67; Brink and Dawe 1988:14-16). Where a cultural affinity has been assigned, bone uprights are associated most frequently with the Besant Complex (Neuman 1975:32). It is doubtful that bone upright features in general can be considered diagnostic of any specific time period or related to an ethnic group given their broad distribution. For example, bone uprights have also been reported from Europe and Asia (Leonova and Min'kov 1988; Semenov 1964).

The function of bone upright features is enigmatic; however, Newman favours an interpretation that such features were used as anvils for lithic reduction or bone splitting (1975:32). This interpretation does not seem tenable for either of the HSI uprights. The elements in the bone upright features at HSI were oriented with articular ends upwards; however, a careful scrutiny of these upper surfaces failed to reveal any indication of use, other than that which could be attributed to blows from driving them into the ground. Newman observed a similar lack of such use wear on his bone uprights which were similarly oriented; however, he suggests that the "anvil" could have been cloaked with a hide which would prevent such damage. If our uprights were used as anvils, we would expect lithic debitage or bone scraps to be concentrated nearby, and no such concentrations were found.

In a camp site situation, bone uprights need not have a common function, nor one which can always be determined simply on the basis of composition or wear. The plentiful supply of bone at HSI would have made it a readily available substitute for applications otherwise reserved for wood or stone. Given the occurrence of bone upright features in the camp site area of a site, it might be speculated that these served as expedient stakes or pegs in an area poorly endowed with wood to serve such purposes. Several historical photographs attest to the use of a multitude of stakes in a camp site situation for such tasks as holding down the bottoms of tipis (e.g., Heitzmann 1983:109) or pegging down hides (e.g., Bushnell 1922:Plate 5a).

There are numerous other site functions that could require the use of a peg or stake and could be manifest in an archaeological context. For example, Wilson documents the historical period use of a "short pin of ash wood" which was driven into the ground for use as a horse tether (1924:155, 181). We know from the recovery of historical period artifacts at HSI (Reeves 1978) that use of the jump continued into this time period and could well have included the presence of horses. Hassrick, on the construction of the Sioux tipi, notes that, after the original tripod foundation was set up, it was "usually secured with a guy rope to a stake driven into the earth at a point approximately in the centre of the tipi" (1964:184). This construction detail is corroborated by an observation by Alexander Henry who described the tipis used by the Assiniboin as:

> . . . tents of a circular form, and composed of dressed ox-skins, stretched upon poles twelve feet in length, and leaning against a stake driven into the ground at the centre (Henry 1809:256-257 in Bushnell 1922:71).

It can be noted that, although tipi rings are not common at the HSI processing area, some do occur and could have employed bone pegs.

It might be added that Maximillian observed that the "leather tents of the Blackfeet" were identical to those of the Sioux and Assiniboins (1906:104). Wilson provides a sketch of the manner in which two stakes were driven crosswise into the ground for a Hidatsa tipi anchor (1924:267). In the winter, a shallow hole was dug into the hard ground with an axe into which a supportive tent pin was driven (Wilson 1924:243). A rope conceivably could be tied around a number of bone elements after they were nailed the ground, or perhaps it was tied around the shaft of one element and the others used to wedge it firmly in the ground. Munson (1984) similarly has suggested that multiple bone uprights were used to hold guy lines for tipi support. We have found it exceedingly difficult to drive wood stakes into the ground at HSI; the result was usually the splitting of the wood. The difficulty was attributed to both the toughness of the compact soil and the density of subsurface cultural material. Green bone may have sufficient toughness and resiliency to make it more suitable for such a function.

Turney-High observed of the Flathead that setting up the tipi was "easily accomplished by one woman in about fifteen minutes" (1937:101). This construction was initialized by the placement of the tied foundation poles on the ground. A stone was placed against the rearmost post to anchor it as the woman raised the opposite post by lifting and pushing it towards the former. It might be speculated that in the absence of a rock heavy enough to do this job, a few bones were hammered into a tight mass to provide the requisite resistance. Such a function likely would not produce evidence of use on the bone.

Some bone uprights may be the remnants of shims were used to tighten a post in the ground. Although ethnographic accounts of the practice of using shims as post supports are lacking, Catlin provides at least two examples of the Sioux using two or three pegs of some sort to wedge a pole in the upright position (1973:plates 96 and 97). Archaeological examples of the use of bison bone to support posts have been observed at the Wahkpa Chu'gn site (Brumley 1971), at Mortlach (Wettlauffer 1955:43), and at the Scoggin site bison pound (Frison 1978). Frison (1978:211) reports that "long bones had been shoved into holes alongside the posts, presumably to straighten leaning posts."

Another possibility is that the bones were stuck into an existing hole, such as a rodent burrow, simply to fill it up. This could have been done to reduce the likelihood of accidentally stepping in it or perhaps by children playing. For example, some youths were recently observed successfully snaring a ground squirrel at HSI by plugging all but one of the holes it used with loose, fire-broken rock. They eventually captured the animal when it emerged from its one available exit. As much bone would have been available on the surface, and it could have been similarly stuck in the rodent holes. Snaring of gophers appears to have been a popular pastime, at least of Hidatsa boys, as described in Wilson (1924:165-171), although no specific mention is made of plugging holes.

While the two bone upright features did exhibit some similarities, it would seem that these uprights served different functions. The two tibiae in Feature 86-2 may be good candidates for the support props or shims which held a wooden post or stake in position. A void indicated by the dark soil adjacent to the bones indicates that the hole into which the tibiae were placed was originally much larger than the area occupied by the bones alone. We interpret this as a hole that was dug probably to accommodate a post which was fixed firmly in the ground by the insertion of two tibiae used as shims.

The characteristics of bone upright Feature 85-7 are more consistent with an interpretation as the anchor of some sort of guy line or tether. Unlike Feature 86-2, no space is delineated by the distribution of the dark soil of the feature into which a post could have been inserted. Without any indications of use wear or associations, any interpretations of the specific function of this feature must be considered speculative.

Pit Features (n=5)

The five pit features recovered during the 1985 and 1986 seasons added to the already considerable number of such features recovered previously at HSI (Brink *et al.* 1985, 1986). As with the bone upright features, when excavation proceeded below the top soil, the darker soil fill of these pits contrasted sharply with the surrounding, lighter coloured and usually sterile matrix. Unlike the bone uprights, however, the upper limits of the pit features were hard to establish, as the pit fill contents were essentially identical to the very dense cultural material in the top 20 cm of the excavation. In other words, the upper 20 cm of the excavation were so rich in cultural material, especially fire-broken rock and bison bone, that excavation floors revealed a continuous spread of these materials, and the concentrations of a pit did not stand out. Only as the surrounding soil became progressively sterile did a pit feature become obvious. For this reason, it can be presumed that the uppermost contents of pit features were removed with the surrounding fill."

Of the five pit features recovered in the processing area during the 1985 and 1986 excavations, at least three appear to have functioned as either boiling or roasting pits (85-4, 85-5 and 85-6). The function of the two other pit features (85-3 and 86-1) remains enigmatic.

Feature 85-3

This feature was encountered at a depth of 20 cm below the surface and consists of an elongate depression about 60 cm long, 30 cm wide and at least 20 cm deep (Figure 8). It was at the 20 cm depth that the dark, organic soil, numerous bison elements, and pieces of fire-broken rock showed up in marked contrast to the adjacent sterile, buff-coloured subsoil. In addition to the part of the depression that was full of cultural material, three rodent burrows were outlined clearly; two of these entered the feature on the north side and one large one on the south. Their existence poses the interpretive dilemma of ascertaining whether this is in fact a cultural feature or a collapsed rodent burrow system or nest. An examination of the faunal material, which consisted exclusively of bison bones, failed to provide any indication of use or patterning which might support an interpretation as a cultural feature. If anything, the faunal material was consistent with the variety and condition of faunal material recovered elsewhere in the camp site midden (Figure 12).

In addition to the faunal material recovered from this pit, four pieces of fire-broken rock, weighing a total of 1.1 kg, and two lithic artifacts, one retouched flake and one core, were recovered in the fill. A dark, organic layer was observed at the base of this pit; however, its origin is unknown.

Feature 85-4

This feature is a roughly circular, bowl-shaped pit, measuring 1 m in diameter at the uppermost level, that is, at a depth of 10 cm below surface. Other than the approximate configuration provided by a dense concentration of faunal material at the 10 cm level, the outline of the pit initially was not discernible from the surrounding matrix. The pit outline became quite distinct by a depth of approximately 20 cm (Figures 13 and 14, layer 1) where the surrounding matrix had become a sterile, buff silt that was readily distinguishable from the dark, organic, rich pit fill.

The excavation strategy was geared to removing cultural material and fill to expose the basin, thus providing us with the size and shape of the original pit. The excavation by arbitrary 10 cm levels for this feature was considered impractical, as the material in the fill was so densely concentrated. Rather, the pit was excavated in layers of pit fill. Excavation proceeded until a continuous layer of bone and fire-broken rock was exposed. These were then mapped and photographed *in situ* (Figures 14 and 15), and all mapped materials were removed before excavation resumed. Therefore, layers are arbitrary and not necessarily equivalent in terms of either volume or depth parameters, although their relative stratigraphic integrity was maintained.

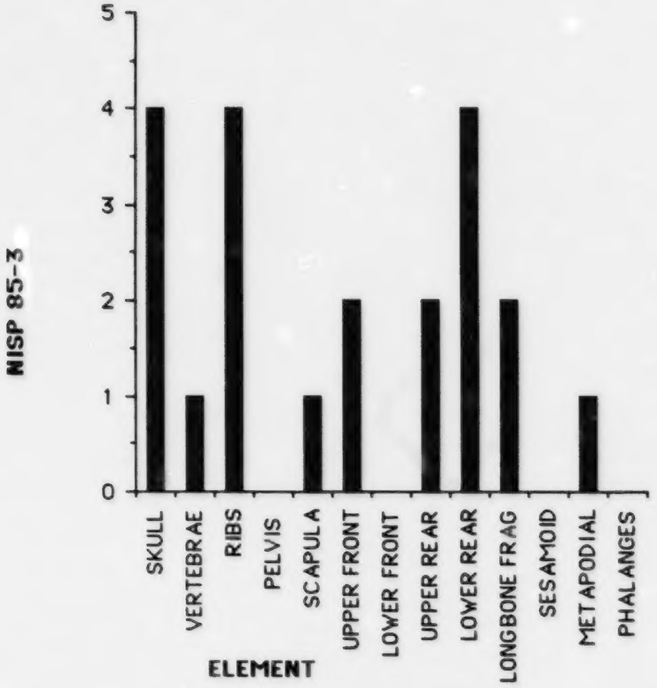


Figure 12. Total NISP of bison elements in feature 85-3.

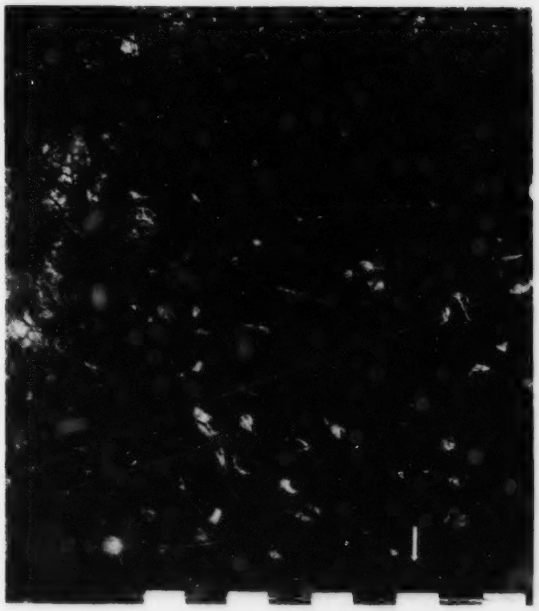


Figure 13. Plan view of pit feature 85-4, layer 1, at a depth of 20 cm below surface.

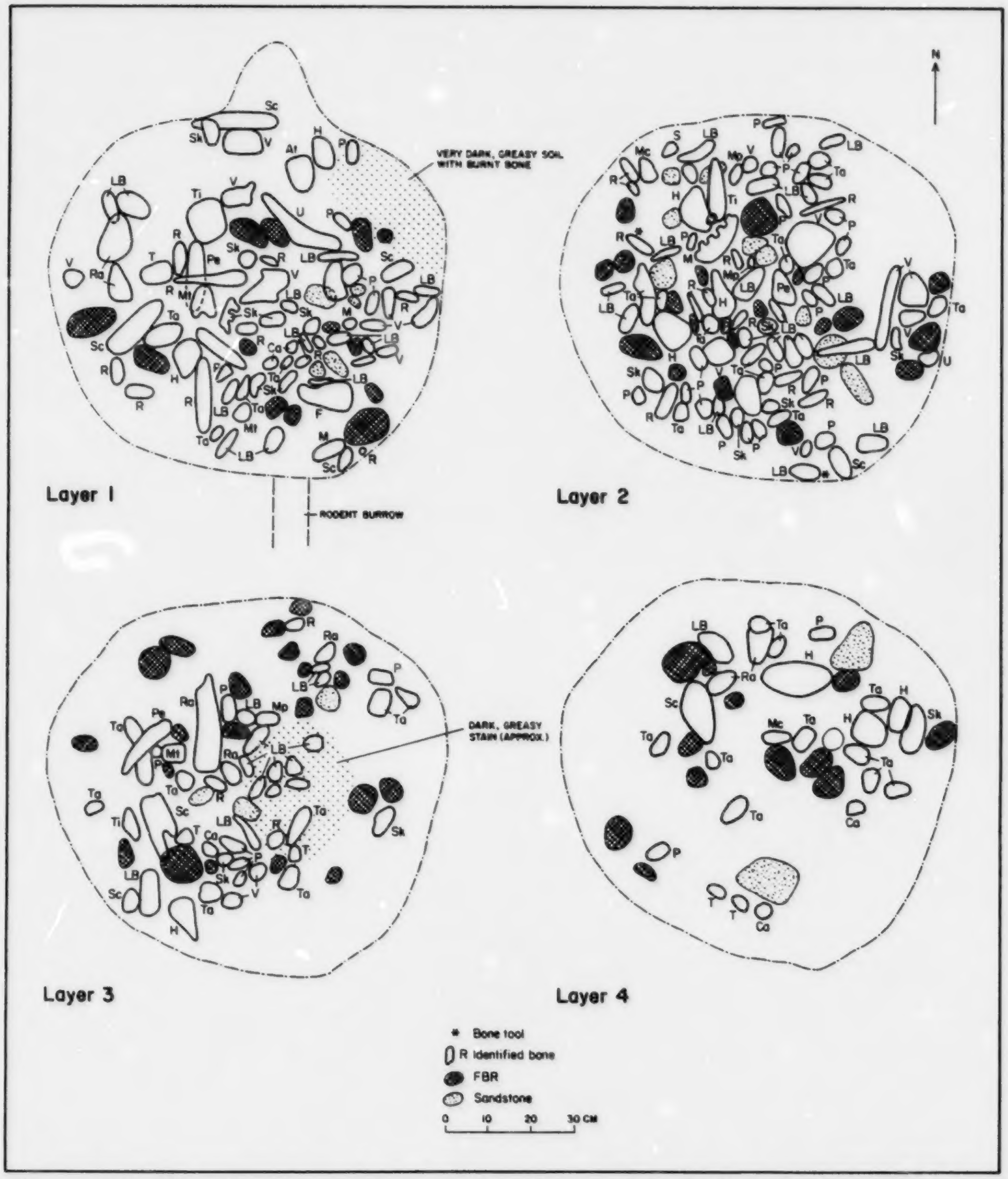


Figure 14. Plan drawings of excavation layers 1 to 4 of pit feature 85-4.

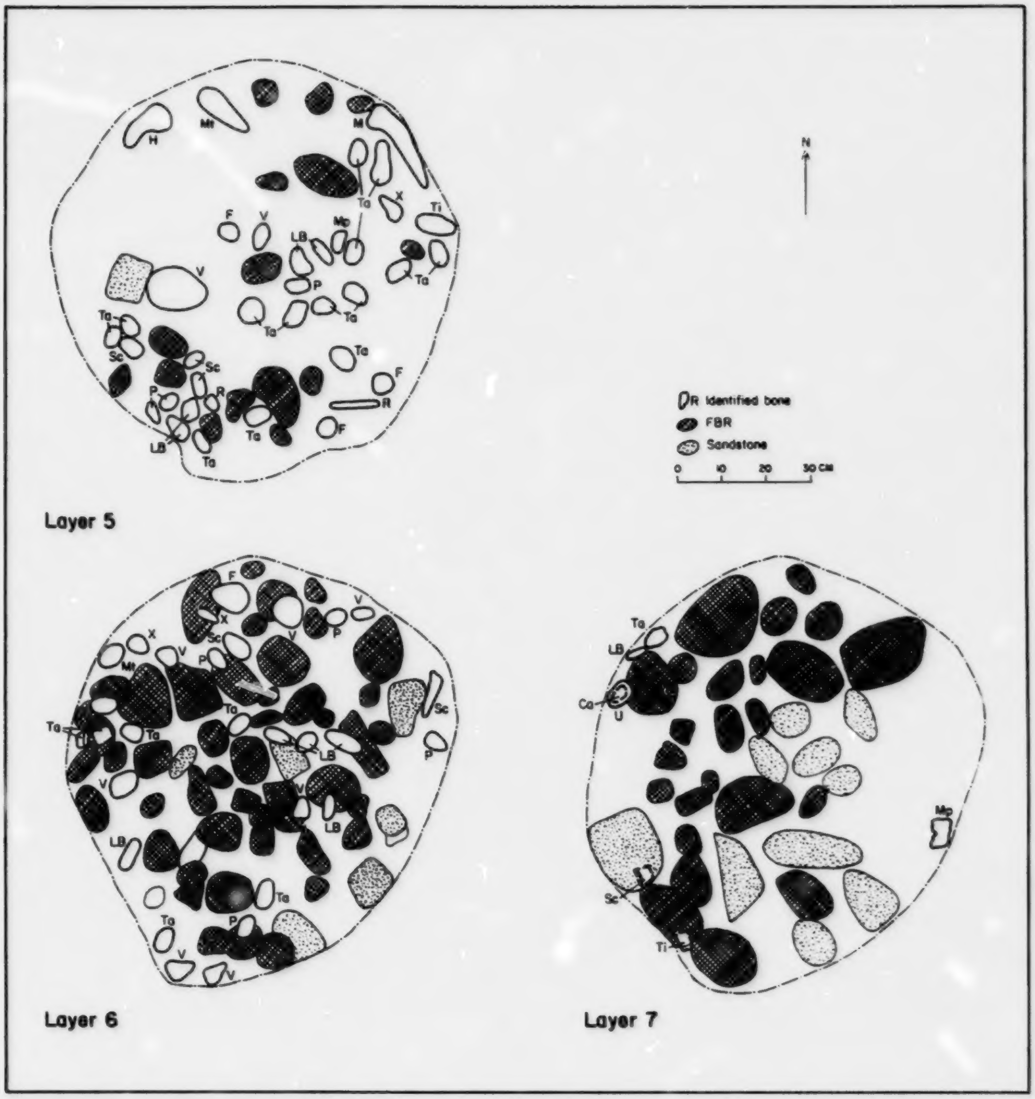


Figure 15. Plan drawings of excavation layers 5 to 7 of pit feature 85-4.

The diameter of the pit did not decrease significantly until near the bottom of the feature, at a depth of 65 cm (Figures 15 and 16). The fill from this feature was packed with a total of 153.6 kg. of fire-broken rock, most lining the bottom of the pit (Figures 15 and 16), 261 *Bison bison* bone elements and fragments (Figure 17), one canid humerus, 100 lithic artifacts, and four bone tools. A more complete description of this feature and its contents can be found in Mann (1986). Of some interest is the observation that the frequency of FBR increased with pit depth, and the reverse was true for faunal material (Figures 18 and 19). The fire-broken rock (FBR) in the bottom of the pit (Figure 16) was characterized by the angular fracture surfaces and the crazing and crumbly texture typical of heated rocks which have been either immersed or doused with water. The FBR found in the lower layers apparently represents the actual stones, more or less *in situ*, that were used for the operation of this pit feature.

The bulk of the faunal material, artifacts and FBR in the upper layers does not appear to relate to the original use of this pit, rather it represents debris that fell into the pit after it was abandoned. In the upper layers, cultural materials were not as dense as in the bottom, and the type and condition of the faunal elements represented (Figure 19) are not consistent with what we would expect in either a boiling or roasting pit context.

Average weights of elements from each excavation layer are consistent, with a mean weight of 80.0 g per bone element, except in the deepest layer (7) where specimens averaged 55.3 g. The ten elements represented in this lowest layer are all in fragmentary condition, and these may relate to the original use of the pit.

A thin, greasy film of charcoal occurs on the floor of this pit. It is not accompanied by either ash or an underlying oxidation stain. In addition to the charcoal described above, two thin, dark, organic (charcoal?) stains occurred in layers 1 and 3 and may represent the later reuse of the existing pit. The episodic reuse of the pit also is suggested by the dates obtained on bone from the various pit layers. It is possible that, if the pit was reused, it may have served alternate functions for either boiling, steaming or roasting.

Although the artifactual content of the feature is considered to be a fortuitous association in this pit context, the styles of three relatively complete projectile points recovered here are not inconsistent with the dates

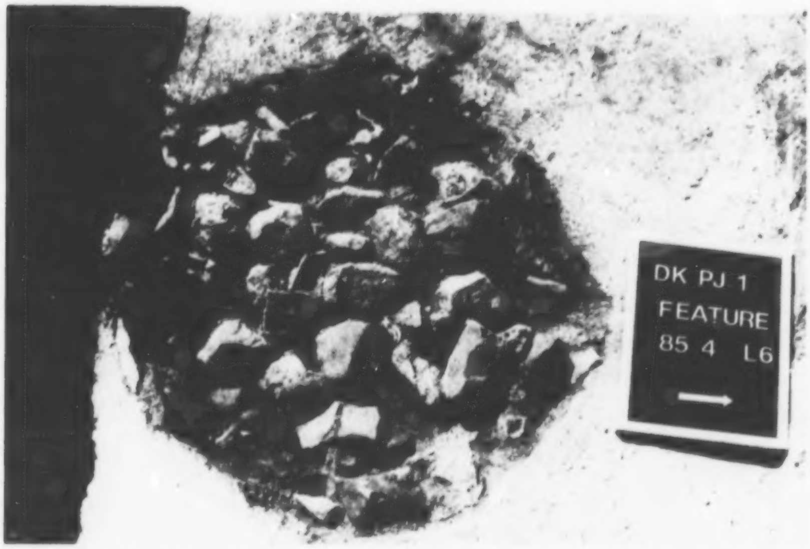


Figure 16. Plan view of pit feature 85-4, excavation layer 6, near the pit bottom.

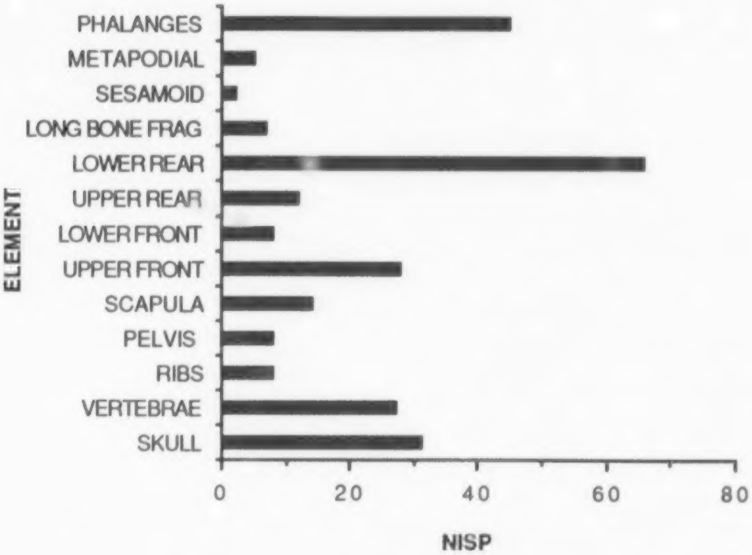


Figure 17. Total NISP of bison elements in feature 8-4.

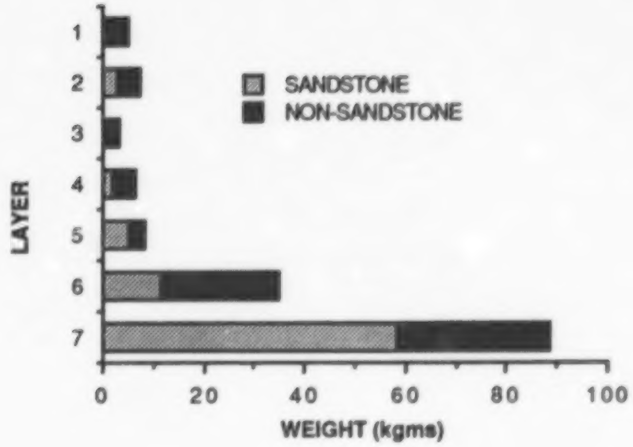


Figure 18. FBR distribution by excavation layer in feature 85-4.

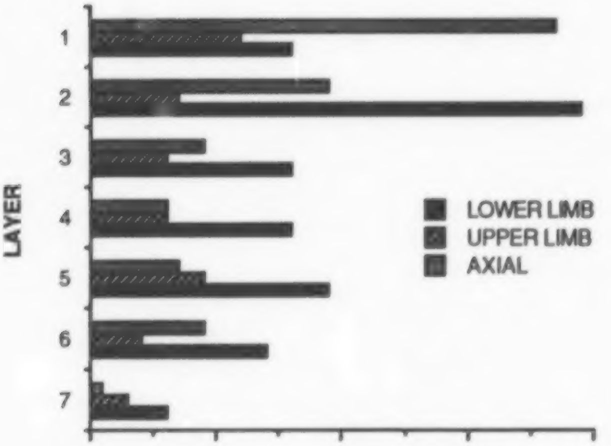


Figure 19. Summary of bison bone distribution by excavation layer in Feature 85-4.

obtained from the pit. The two projectile points that were found in the top layer of this feature are small arrowheads resembling Old Women's Phase types, whereas the one point preform in layer 6 more closely resembles the Avonlea type.

As reported in a previous chapter, eight radiocarbon dates were obtained from this feature. All dates are in years before present as follows:

Layer I: 1030 ± -150 (AECV 233C) Bone collagen
Layer I: 690 ± -150 (AECV 249C) Charcoal
Layer 3: 1250 ± -180 (AECV 232C) Bone collagen
Layer 4: 410 ± -130 (AECV 248C) Charcoal
Layer 5: 1280 ± -100 (AECV 231C) Bone collagen
Layer 6: 680 ± -120 (AECV 250C) Charcoal
Layer 7: 1080 ± -90 (AECV 241C) Bone collagen
Layer 7: 1250 ± -90 (AECV 191C) Charcoal

With the exception of the two dates from base of the pit, little harmony exists between dates obtained on bone and those obtained on charcoal. The charcoal that was collected from layers 1 to 6 occurred as isolated pieces which were picked from the matrix in each level to provide enough material for a date. The charcoal collected from the deepest layer occurred as small pieces collected from a charcoal-rich film lining the pit bottom. The two basal dates (AECV 241C and AECV 191C) are considered to approximate the date of the last and principle use of the pit. Later dates are believed to reflect the disturbed nature of the overlying materials. The dates on bone derived from these upper levels apparently reflect a fairly rapid infilling of the pit depression. Later, charcoal may have filtered down through holes in the fill, possibly down rodent burrows, introducing more recent organic material to an otherwise older fill.

Feature 85-5

This feature was located about 10 m west of the block excavation area (Figure 2). Unlike the features exposed in the latter excavation, Feature 85-5 was uncovered by a backhoe during the excavation of a trench dug to provide a water supply to the interpretive centre (Figures 9 and 20). During this operation,a deep soil profile was exposed, revealing a rich, organic Ah horizon overlying a sterile buff-coloured silt. In this profile, a relatively deep pit feature was observed intruding into this sterile subsoil (Figure 20). This feature was different from pit features recovered previously in the processing area in that it was lined on the bottom with flat, sandstone slabs (Figure 21). We considered it necessary to salvage as much as possible from this unique feature, as further excavation of the well-head pit and trench would certainly destroy the remainder of the feature.

Examination of the soil profile (Figure 20) revealed a continuous layer of cultural material above the feature, at a depth of 40 cm below the surface (30 cm above the floor of the pit), indicating that the pit must have predated the deposition of this level. The top 30 cm, designated "level 1" in this excavation, was shoveled and screened to permit quick access to the feature. A pocket of clean, white ash and a small charcoal stain were observed just above this layer of cultural material. These probably marked the location of a small bison chip fire (Figure 20). The excavation of this ash failed to produce any associated faunal remains or artifacts.

In the lens of cultural material, an articulated vertebral column was recovered. It included thoracic vertebrae 9 to 12 and lumbar vertebrae 1 to 3 (Figure 22). Given the provenience of this articulated unit in the undisturbed lens of cultural material overlying the pit feature, it is not considered to be associated with this feature. This section of vertebrae was the first articulated unit of its kind recovered in the processing area. The integrity displayed by these articulated elements is unusual, given that apparently were lying exposed on the surface rather than buried in a pit. This may be an indication of a relatively rapid rate of soil deposition in this area. At the Wardell site, Frison (1973:54) describes an apparently unopened roasting pit which included in its contents ". . . a section of a vertebral column containing number 2 through number 11 thoracics with the proximal ends articulated and rib and dorsal spines chopped off close to the bases . . ." The construction of the roasting pits described by Frison are different from the pit features we recovered, in that they are conical in shape and covered with sandstone slabs.

Beneath the layer of cultural material described above, the pit feature was clearly visible in the surrounding sterile soil. Although part of the feature had been removed accidently during the well trench construction, it appears to have been a roughly circular, basin-shaped pit with a maximum

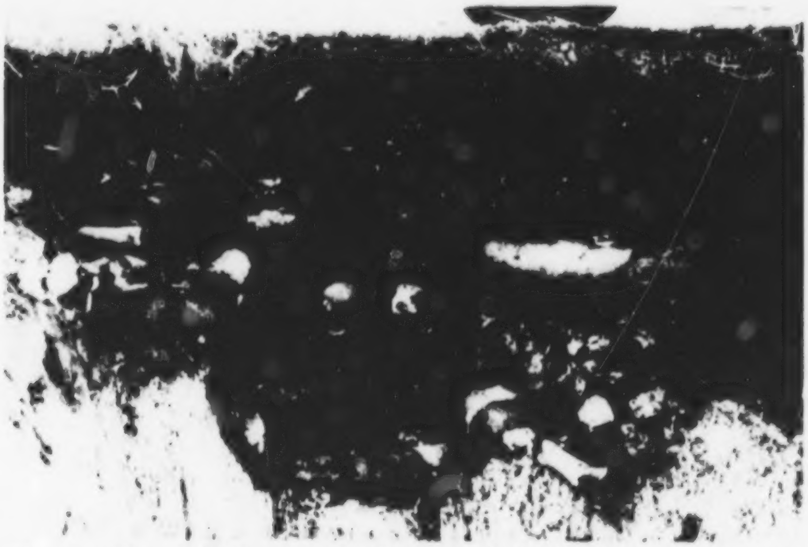


Figure 20. Profile of pit feature 85-5 exposed during backhoe excavation of water supply trench.

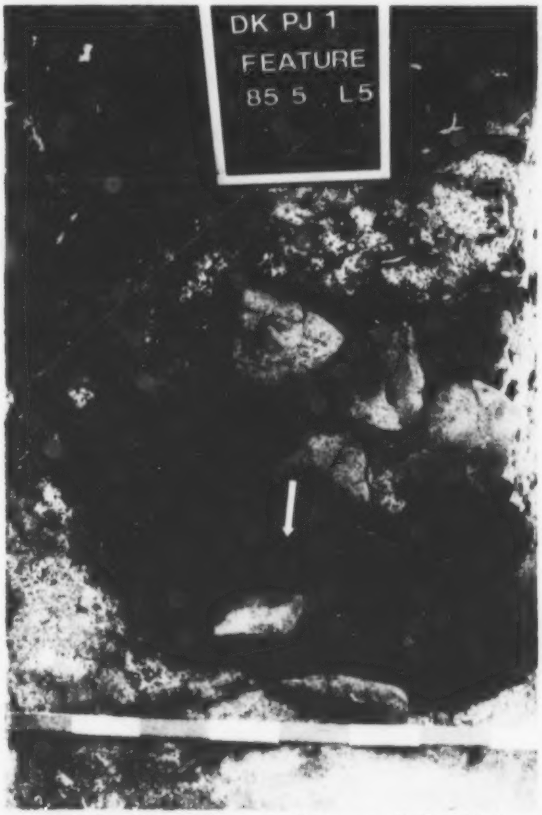


Figure 21. Photograph showing the sandstone slabs lining the floor of pit feature 85-5.

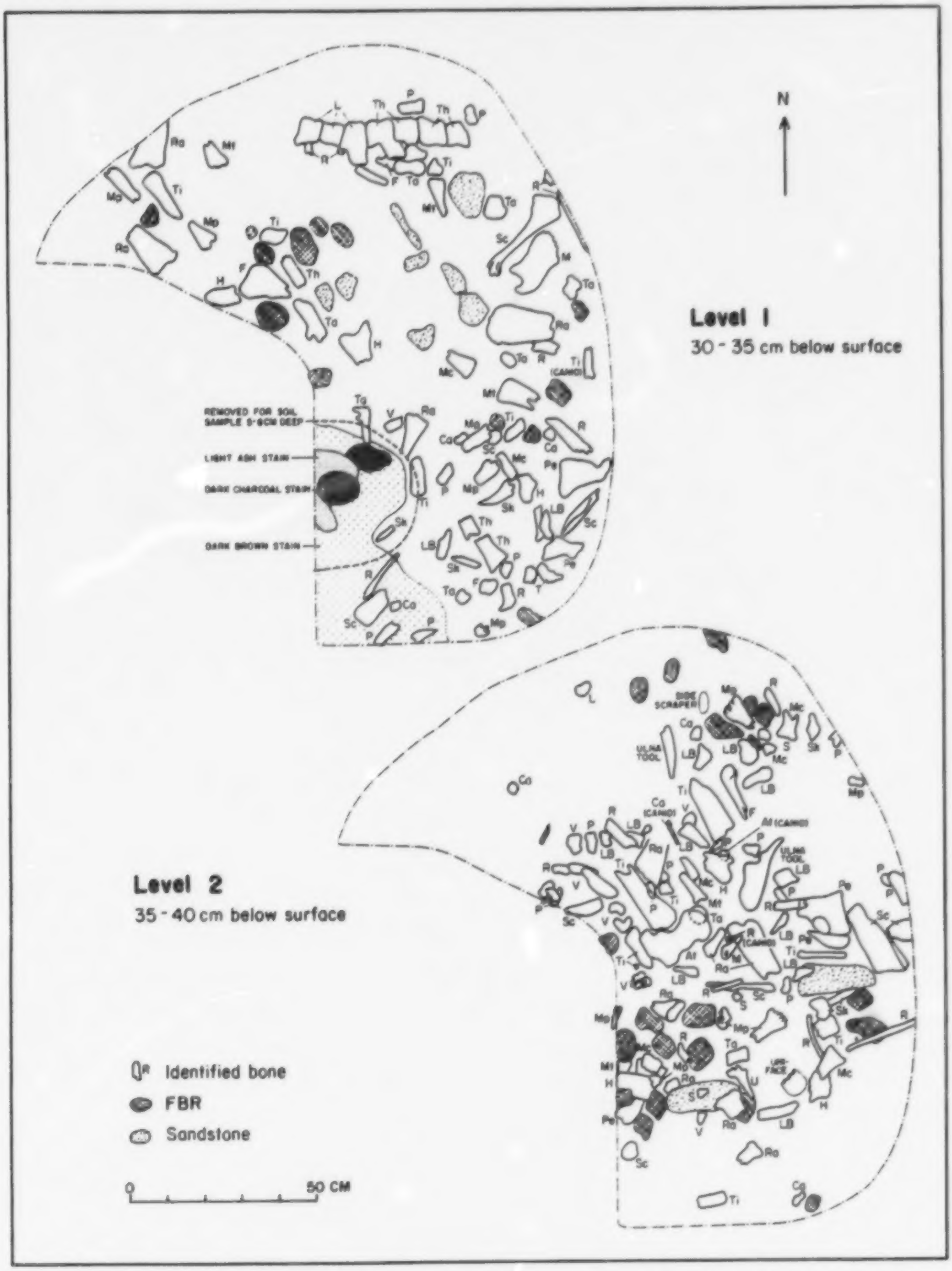


Figure 22. Plan drawings of excavation layers 1 and 2 of pit feature 85-5.

diameter of 120 cm and a maximum depth of 70 cm. Very little cultural material was recovered in the area directly above the floor of the pit (Figure 23). This probably indicates that the feature had been emptied of its contents before it was abandoned. The floor of the pit was lined with large sandstone slabs (Figures 21 and 24) which were scorched and reddened on their uppermost side. Some charcoal and other burned organic material was found both on top and beneath the slabs. It appears that a fire had been constructed before and after the insertion of these large sandstone pieces.

Three radiocarbon determinations were obtained from the base of this pit feature: 1100 ± 80 years B.P. (AECV 247C) on wood charcoal from the base of the pit, 1790 ± 80 years B.P. (AECV 234C) on bone collagen from a composite bone sample in the pit, and 830 ± 80 years B.P. (AECV 235C) on bone collagen from a portion of the articulated vertebral section above the pit. The lack of agreement among these dates is something of an enigma. The early date is aberrant, not only in the context of this feature, as it occurs in a stratigraphic position between two more recent determinations, but also because it is the earliest date obtained in this area. There is a possibility that, during the excavation of the original pit, extant cultural materials from an earlier occupation were incorporated with the removed fill. The later date on the vertebral material supports our contention that these specimens were not part of the original pit feature. It is probably safe to assume that the original pit was constructed sometime between 1,100 and 1,800 years ago.

Feature 85-6

This feature is a rock-lined pit which was only partly exposed during the 1985 field season (Figures 8, 26 and 27). The outline of the pit was first differentiated from the surrounding matrix at a depth of 17 cm below the surface where the dark fill contrasted sharply with the surrounding matrix. In plan view the pit measures 60 x 40 cm (Figure 26); however, these dimensions account for only the exposed portion. The pit would extend further in both the south and east dimensions if the entire feature was exposed. The maximum depth of the pit occurred at 43 cm below the surface, and it appears that this represents the maximum depth this feature would achieve even if it had been excavated in its entirety. The floor of the pit was lined with a very dark grey to black, greasy, organic residue of

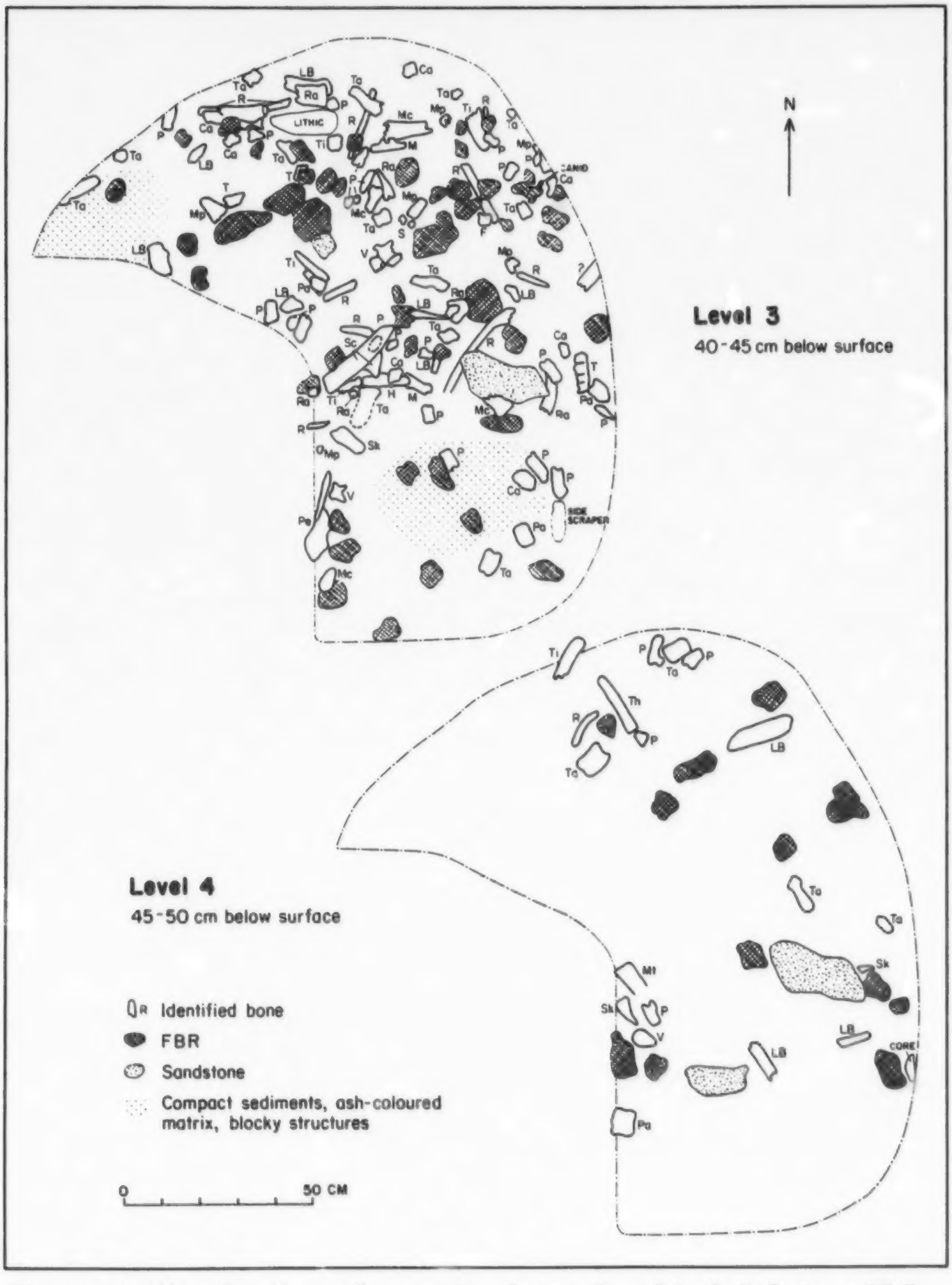


Figure 23. Plan drawings of excavation layers 3 and 4 of pit feature 85-5.

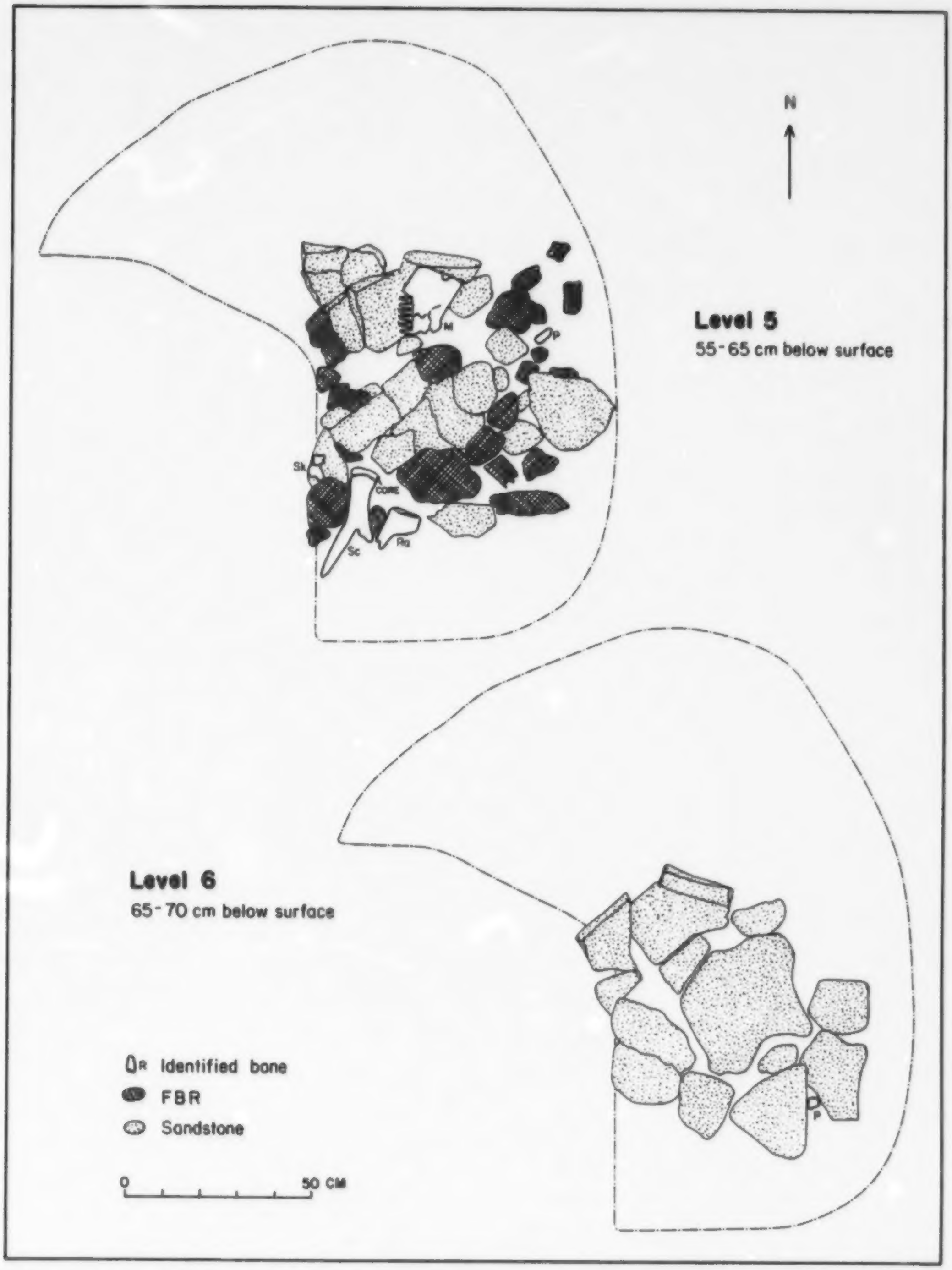


Figure 24. Plan drawings of excavation layers 5 and 6 of pit feature 85-5.

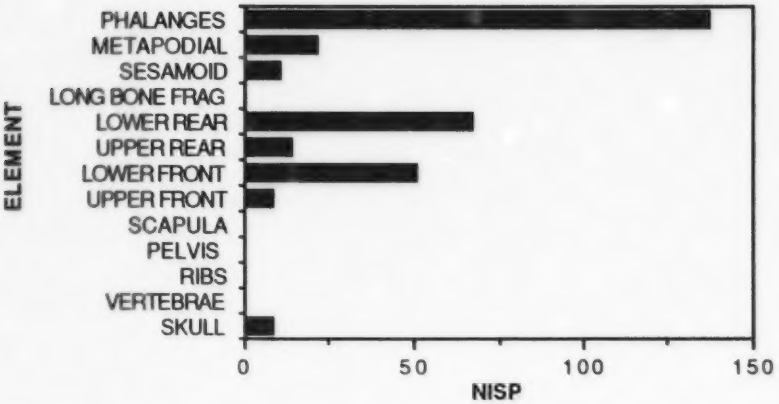


Figure 25. Total NISP of bison elements in feature 85-5.

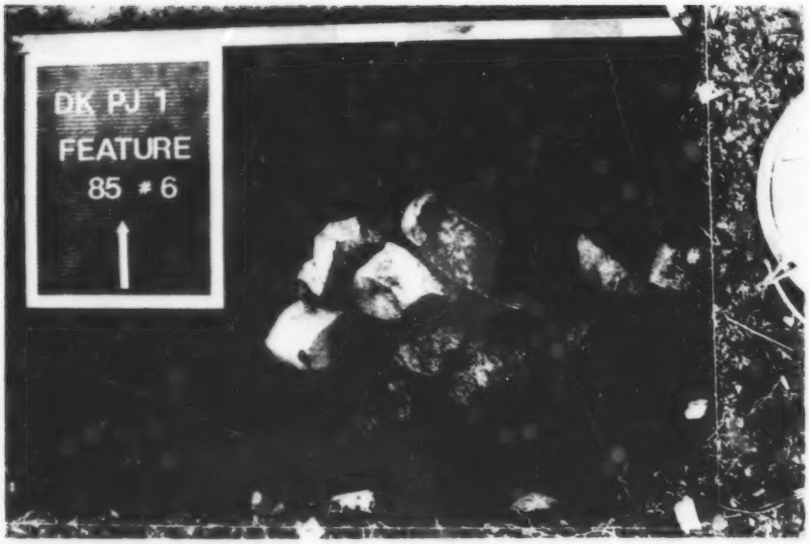


Figure 26. Plan view of concentration of FBR near base of pit feature 85-6.

Figure 27. Profile of pit feature 85-6.

uncertain origin, although it appears to be composed of soil saturated with fine particles of charcoal. If this material is charcoal, it must have been redeposited in the pit as the contact of the adjacent underlying sterile subsoil bears no evidence of the reddish thermal alteration typical of this soil when it is exposed to heat (Figure 27).

Immediately on top of this and filling the bottom of the pit was a total of 26.25 kg of non-sandstone FBR (Figure 26). The faunal material associated with the pit consists of a few (n=6) small scraps of long bone fragments, which occurred both above and below the rock fill, and one small rib fragment, all presumed to be bison. The lack of faunal material would seem to indicate the original contents this pit may have been removed.

Feature 86-1

Feature 86-1 consists of a relatively shallow, basin-shaped pit, lacking any obviously associated faunal or artifactual material. It probably would not have been recognized as a feature except that the dark, organic, rich fill in the pit intruded into a sterile sand lens, and this dark feature fill contrasted sharply with the lighter subsoil which it truncated. The depression formed by this pit measured 62 cm north-south and extended 17 cm west of the wall of the excavation at a depth of between 20 and 35 cm below surface. This feature occurred adjacent to an area excavated in the previous year (1985), and it was apparent that this pit should have had an eastern extension in this excavated area (Figure 8). Due to a lack of clear stratigraphy in this adjacent area, however, the eastern extreme of this pit was not observed during the 1985 season (Brink and Dawe 1987; Wright and Brink 1986). No function could be determined for this pit.

Discussion

Based on excavations conducted in the processing area, it is evident that pit features are probably represented in the hundreds at HSI. Three of the pit features described above, features 85-4, 85-5 and 85-6, are similar in many respects to those previously excavated. The co-occurrence of fire-broken rock, faunal and organic material in the the pits indicates a function related to food processing or cooking. Several ethnographers and historians have provided descriptions of the use of boiling and roasting pit by the native peoples of the Plains. A comprehensive review of these has provided us with several analogues of use in interpreting the pit features found at HSI (Smith and Cole-Will n.d.).

Boiling pits were usually lined with a hide to hold water, and red hot rocks were added to the water until it boiled. This often required removal and reheating of some of the stones. Boiling pits were constructed principally to boil meat, which was the favourite means of cooking meat, but also to render grease.

> Bison bones not needed for making tools were crushed, especially the long bones. The bone mash was later rendered for the grease which, they say, "is the best lard you ever tasted" (Turney-High 1941:37).
>
> Very little of the buffalo is lost, for after taking the marrow, they pound the bones, boil them, and preserve the oil (Brackenridge 1814:260).

The pit construction used for grease rendering and meat boiling was similar, and it seems most likely that any pit would be used for both functions if necessary. The best clues to pit function are the nature and character of the stone and faunal material recovered, when they can be observed to represent a primary association in the pit. Unfortunately, pits also form a natural repository for nearby debris. Given ideal circumstances, where only one function occurred, we would predict a high incidence of fractured limb bones and non-sandstone boiling stones in a grease rendering pit. In contrast, a cooking pit may be expected to include a wider variety of elements, in less fractured condition, as well as the inclusion of sandstone as a boiling stone. Sandstone has been observed to lose grit during boiling episodes, and this grit can become suspended in grease during rendering. Neither type of boiling pit should contain charcoal, ash or burned bone in primary association with the pit fill, nor should oxidation stains from intense heat occur in the matrix beneath the floor of the pit. Boiling meat may not have required as much effort to raise and maintain a high water temperature as did grease rendering, since meat usually was boiled only long enough to lose its red colour, only about 5 to 10 minutes according to Grinnell (1961:106). This latter consideration might result in a relatively lower amount of boiling stone associated with pits used only for cooking.

Although many boiling pit features have been recovered in the processing area at HSI, the number probably does not do justice to the actual amount of boiling activity represented. It has been observed that rodents have selected areas of disturbance, particularly pit features, as favourite loci for their subterranean activity, no doubt as an adaptive response to the very compact, tough nature of the subsoil at HSI. This characteristic of the soil would similarly pose a problem for any prehistoric digging activity requisite for pit construction. Pits were probably pressed into service several times to avoid the difficulty involved in digging the original hole. Historical accounts indicate that this problem often was avoided by using a bison pauch supported on the sides by sticks thrust into the ground as a container for boiling (Hassrick 1964:189, Wissler 1910:27). Such a structure would leave little in the archaeological record other than a scattering of boiling stones and bone fragments on the surface, which could certainly account for some of the multitude of such materials which carpet the processing area at HSI.

Roasting pits were lined with hot rocks that were either heated in place by means of a fire constructed directly on the rocks in the bottom of the pit (Chittenden and Richardson 1969:488, Grinnell 1961:105, Turney-High 1933:263) or heated prior to being placed in the bottom of the pits (Wissler

1910:25). The roasting pit was used frequently for the preparation of camas root; however, it was observed to be pressed into service for roasting meat, particularly whole calves, "at the time of the buffalo drive" (Wissler 1910:25). Wissler describes two methods of roasting calves in such a manner: one was a "dry cook," and the other apparently incorporated steam. In the latter instance, dressed calves were wrapped in fresh hides and placed in a pit filled with hot stones covered with willow branches and grass. Water was then poured in the pit, and the pit was covered with more hides and earth. A fire was constructed over the top of the finished product (Wissler 1910:25, 26).

The contents of roasting pits should vary considerably from those used for boiling. The fractures exhibited by rocks used to line a dry roasting pit should exhibit the more curvilinear spall fractures associated with expansion due to heating. Crenelated fractures, which are associated with contraction due to rapid cooling, should only be observed in roasting pits incorporating the use of water. Ash, charcoal or burned bone could occur in the pit fill, and, in cases where rocks were directly heated by fire in the pit, an oxidation stain would likely be associated in the underlying soil matrix. In a wet roasting pit, the ash and charcoal could be washed into the bottom of the pit between the rocks. The lithic material selected for use in lining roasting pits could be either sandstone or non-sandstone, since both have good heat retention and radiation properties; however, given the poor supply of non-sandstone materials, such as quartzite, on this site, we would expect local sandstone to be more prevalent in roasting pits. The less plentiful and more difficult to obtain materials likely would be reserved for boiling tasks, a use for which the local sandstone was poorly suited.

The construction details of the basin formed by the sandstone slabs in Feature 85-5 agree in every respect to those described for ethnographic roasting pits. The scorching and reddening of the sandstone slabs in the floor of the pit indicate that a fire had been made to heat these stones, which have not been moved since the pit was used. Alternatively, pit feature 85-6 appears to be a boiling pit, perhaps for boiling food rather than rendering grease, since, in the latter case, a better representation of grease rich faunal debris would be expected. This feature can be contrasted with the roasting pit 85-5 in that none of the stone in the fill was sandstone, and there was no evidence of an *in situ* fire.

The function of pit feature 85-4 is particularly puzzling because it has attributes characteristic of both roasting and boiling. It may well have served both functions at different periods of time. Although the character of the FBR in the pit bottom appears to have been the result of use as boiling stones, most of the FBR near the bottom is sandstone (Figure 18) which is considered inferior for grease rendering. The charcoal in the pit bottom appears to be a fortuitous occurrence of sodden charcoal which settled amongst the stones in a water-filled pit. This would support an interpretation of boiling; however, it is hard to account for so much charcoal finding its way into the water. Alternatively, this pit could represent a wet roasting pit. Brush and grass incorporated into "wet" roasting pits would tend to carbonize rather than burn down to ash. This could account for the occurrence of a charcoal film in the bottom of the pit. This interpretation is also supported by the non-specific nature and the crazed condition of the FBR in the pit.

The occurrence of 42 astragali in the fill of Feature 85-4 is also quite unusual. Astragali are extremely hard to separate from the distal tibias with which they articulate. Yet only two of these latter elements were recovered from this pit, and only four navicular cuboids represent the distal articulation. Astragali are very dense, have a minimal grease or marrow content, and were usually discarded articulated with other distal limb elements. The Hidatsa, for example, would throw the "parts of the leg below the knee" to the dogs (Wilson 1924:201, 202). Why the astragali would be so well represented compared to the articulating elements is something of a mystery. Studies on the survival of faunal elements from scavengers tend to focus on long bones, and few data are provided specifically for astragali or other tarsals and carpals (e.g., Binford 1981; Brain 1981; Haynes 1982). This lack of attention in the literature may be an indication of a similar lack of interest of scavenging carnivores who could be expected to favour more grease rich articular ends, marrow bones and cartilage. The peculiar over representation of astragali suggests that this element was not desired by either humans or scavengers and was sufficiently durable to withstand destruction by other taphonomic agencies. The bias of astragali relative to other tarsals and distal tibias indicates that they were incorporated into the pit after they had been disarticulated.

At the Saamis site (EaOp-6), a prehistoric camp site and bison processing area in Medicine Hat, Alberta, two adjacent clusters of bison astragali representing about 40 specimens were recovered (Congram 1978:plates 30 and 31). In addition to the astragali, a few other elements were present, including at least two distal tibias, a distal metacarpal and a few phalanges. It is clear, however, that the astragali account for the vast majority of the bone in these two concentrations. Unfortunately, the author provides no explanation for this occurrence. The astragali from Feature 85-4 represent about the same number as the Saamis example, but the astragali in the pit at HSI were more dispersed in the matrix. Concentrations of 10 and 12 astragali were recovered from layers 2 and 5, respectively, but these totals were augmented by a greater number and diversity of other faunal elements, as well as FBR. It seems probable that some unknown cultural practice played a part in the disproportionate representation of astragali in Feature 85-4, possibly under circumstances similar to those that produced the astragali clusters from the Saamis site. The function of these elements in pit features remains unknown.

Hearths (n=2)

Two classifications of hearth type have been recognized at HSI: prepared and unprepared hearths (Brink *et al.* 1985:217). A prepared hearth involves the construction of a lining or containment structure, such as an encircling ring of cobbles, whereas an unprepared hearth is the result of an open fire built on the surface. One of each of these hearth types was recovered.

Feature 85-1

This was to be an unprepared hearth feature which consisted of a thin deposit of ash and burnt bone. It was situated in the middle of the rectangle formed by the block excavation and occupied the middle of the north half of unit 44 and the south half of unit 45 (Figure 8). The ash was first encountered at the bottom of the first arbitrary level, 10 cm beneath the surface, and covered an area approximately 80 cm in diameter to a maximum depth of 5 cm (Figures 8 and 28). Of the burnt bone fragments recovered from this feature, the only identifiable pieces were a fragment of

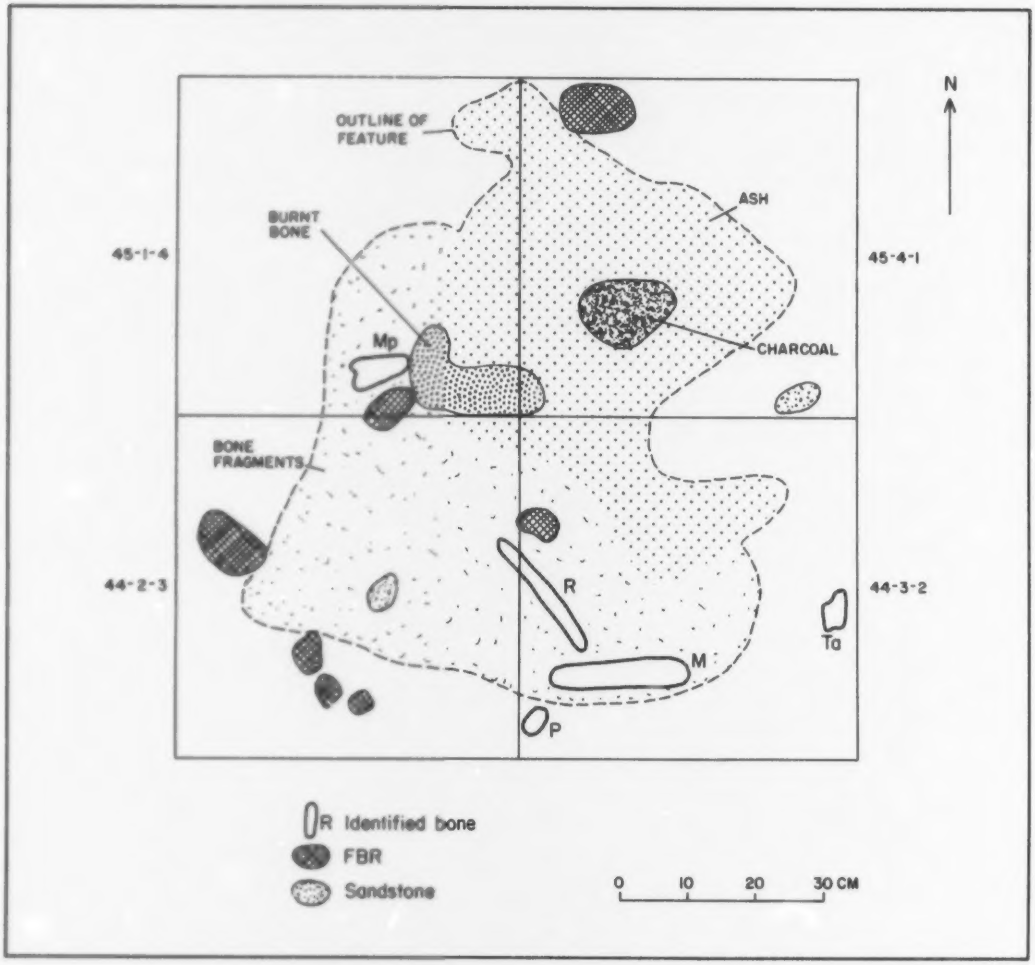


Figure 28. Plan view of hearth Feature 85-1.

a tooth and a portion of a long bone shaft, both presumed to be bison. Given the density of cultural material at this depth, it is probable that some of the matrix, particularly associated faunal material, could have been removed prior to the recognition of this feature. Despite this, it does not seem likely that much of the matrix was lost. With the exception of a small stain and a few small flecks, no wood charcoal was observed; therefore, it appears that the remnant ash can be interpreted as a buffalo chip fire of relatively short duration, probably a single, ephemeral event. Unlike many of the hearths recovered previously in the processing area, this hearth lacked a dark red oxidation soil stain which usually occurs in the otherwise sterile buff-coloured silt beneath hearths. The lack of a red stain might indicate merely that the heat generated by the fire was insufficient to cause such a stain or penetrate the film of dark organic soil just under this hearth. Alternatively, this may be a dump of material from a nearby roasting pit (see discussion below).

Feature 85-2

This feature, described as a prepared hearth, was encountered just beneath the surface, where an unnatural, fire-broken rock alignment was observed. The alignment consisted of at least eight rocks situated adjacent to each other, including three relatively large pieces of scorched sandstone that formed a northeast to southwest trending arc about 50 cm long (Figure 8). A few non-contiguous pieces of FBR were located opposite this arc. These are thought to have been associated with the feature, although, given the density of cultural material in this area, such an association cannot be proven. At the base of the FBR on the inside of the arc was a thin ash lens about 50 cm in diameter and 2 to 3 cm deep, in which a scattering of small, unidentifiable fragments of burnt bone was observed. Not enough organic material could be recovered from this feature for a radiometric date. No charcoal was observed in this feature; consequently, it appears that the ash was the result of a small, buffalo chip fire.

Discussion

The hearth features described above were found adjacent to each other and quite close to an FBR-lined pit feature (Feature 85-4; see Figure 8). Although the association between either of the two hearths and the pit feature, or all three, may be fortuitous, a nearby fire would have been required to heat the rock used in the pit. There is also ethnographic evidence to support the use of adjacent hearths. Grinnell (1961) describes that the manufacture of pemmican by the Blackfeet required two such hearths. Two fires were allowed to burn down to coals, over which dried meat was alternately roasted.

> After a time, the roasting of this dried meat caused a smoke to rise from the fire in use, which gave the meat a bitter taste, if cooked in it. They then turned to the other fire, and used that until the first one had burned clear again. (Grinnell 1961:107)

If such an association existed between the two hearths, we would expect them to have similar construction features.

It seems more plausible that one of these hearths functioned to heat the stones used in the nearby pit. Brown (1980) describes an archaeological example of "tri-hearths." He interprets three adjacent features as being associated: a hearth is required to heat stones and coals, which are then used in an adjacent roasting pit, and any ash or bone debris removed from this pit before reuse is cleaned out and dumped into an additional pit. Such a "tri-hearth" relationship might exist in the block excavation between the two hearth features and the nearby pit feature (85-4). Hearth feature 85-2 could be interpreted as a rock heating hearth. The rocks in this hearth were primarily sandstone, the principle material used in the lower levels of pit feature 85-4. Feature 85-1 may be considered a dump of ash and debris rather than a primary hearth.

The rock arc around hearth 85-2 could also be interpreted as a largely complete containment structure. A circle of rocks has been used around hearths to aid in the radiation of heat from buffalo chip fires. According to Wilson's Hidatsa informants, "the fireplace was surrounded by stones only when wood was scarce and buffalo chips were used for fuel," otherwise only about five or six stones were spaced about the fire to allow the placement of thigh bones for roasting (Wilson 1924:267, 268). Of further interest is the observation that a particular type of white stone was avoided for this use because it had a tendency to break upon heating (Wilson 1924:268). The use sandstone around Feature 85-2 may indicate a similar consideration of the undesirable effect of thermal shock on other stone types.

Containment rings were also a common precaution, particularly inside tipis where flammable bedding materials were close to the fire. Maximillian, for example, observed of the tipis of the Blackfeet "In the centre of the tent there is a small fire in a circle composed of stones . . . " (1906:107). Such an interpretation would not necessarily indicate that hearth 85-2 was not associated with the nearby pit feature. Turney-High observed that the Flathead preferred to use large logs for hearth containment on the inside of their tipis:

> If logs were available, three fair-sized pieces were laid along a square; the face nearest the door was left free so as not to encumber the cook's work. This was done to prevent the sparks

> from flying on the inflammable floor covering. The boiling hole was next dug on one side or other of the cook's position. This was lined with a hide, the method of boiling being by dropping hot stones into the skin-lined hole (Turney-High 1937:102).

It is interesting to note that the open sides of our hearth features face east, the traditional position of doors in Blackfoot tipis, and south, the side closest to the adjacent pit feature.

CHAPTER 5

FIRE-BROKEN ROCK

INTRODUCTION AND METHODOLOGY

The excavations conducted at Head-Smashed-In by Reeves (1978) and by staff of the ASA consistently have recovered great amounts of fire-broken rock (FBR). Indeed, it is accurate to say that FBR forms a veritable pavement across the processing area. Although the term fire-broken rock is applied to any rock that has been broken due to thermally induced fracture, most of the HSI specimens are fractured cobbles, reticulated with cracks, and typically broken along crenellated fractures. This is characteristic of stones which have been heated to a high temperature and subsequently cooled by quenching in water. In this section, we will present the data on the recovery and analysis of fire-broken rock gathered during the 1985/86 excavations at the processing area. The section will conclude with a discussion of the possible uses of this material at the site and attempt to account for the vast amounts of fire-broken rock recovered from Head-Smashed-In.

Virtually every coarse-textured stone available in the vicinity of HSI is represented in the FBR recovered from the processing area. Rather than identifying every lithic type, our procedure has been to make the more important distinction between stones which have been obtained from the immediate site area and those imported from some distance. At HSI, this distinction is fairly straightforward. There is the locally available sandstone, of which the cliff is composed, and all other rock types, which we refer to as non-sandstone.

The only stone available in any quantity at HSI is Porcupine Hills Formation sandstone which outcrops at the site. However, this material apparently was not preferred for use as boiling stones. Sandstone represents less than 20% of the more than 2,000 kg of FBR recovered during four seasons of excavation in the processing area. Experimentation has indicated that, while sandstone is an adequate medium for transferring heat from the hearth to the boiling pit, there are a number of disadvantages to this material (Brink *et al.* 1986:271-298). Quenching tends to dislodge grit from the surface of sandstone, depositing sand in the pit with the grease or food. Furthermore, sandstone, a porous rock, imparts all of its gathered heat into the pit water in a very short time. Quartzite and other imported rocks are all considerably denser and, thus, retain their heat for longer periods of time. Finally, the porosity of sandstone allows water to penetrate into the rock, making it more difficult to re-heat these stones compared to the dense, imported rock types. Thus, our results suggest that quartzites and other non-sandstone materials were strongly favoured for use in stone boiling and that the sandstone FBR at the site was more often heated for different applications, such as the lining in a roasting pit, or it was heated fortuitously, for example when it was used as a containment ring about a hearth. This is not to say that sandstone was never used as boiling stone material; clearly, it was. Since it was locally available in great abundance and since other materials had to be transported considerable distances to HSI, the local sandstone was no doubt used occasionally out of necessity.

It is evident that the bulk of the FBR was imported from a distance of between approximately 2 and 4 km from the nearest sources of cobbles in exposed till or river gravels of the Oldman River. These preferred types of FBR, primarily quartzite, limestone, dolomite and granite, apparently were reused whenever possible, until the rocks were reduced to lumps too small to be of further use. Our work indicates that the size limit at which FBR is no longer useful is less than 10 cm in any dimension. The results of the 1983 and 1984 excavations further indicate that recycling of the more favoured materials was most prevalent in the "heart" of the processing area (the most intensively used portion of the site) and less so towards the periphery. This has resulted in a size gradient of larger fragments becoming more common with increasing distance from the heart area (Brink *et al.* 1985:243). Of further interest was the observation that larger pieces of FBR were occasionally stockpiled near boiling pits, apparently for reuse (Brink *et al.* 1986:240). Given the paucity of quality stones for stone boiling within easy reach of HSI it is to be expected that considerable effort would be expended in attempts to conserve and curate this commodity.

The analysis of FBR recovered during the 1985 and 1986 seasons at HSI was consistent with the methodology used previously (Brink et al. 1985, 1986). All pieces smaller than 5 cm in any dimension were discarded. All remaining pieces were mapped and removed for analysis. Each piece was classified as sandstone or non-sandstone, and the samples were then counted, weighed and sized according to the 0.5 x 0.5 m unit and 10 cm level of provenience. FBR recovered from designated features was recorded separately. Sizing was achieved by comparison with a sizing chart with increments of 5 cm. Although FBR smaller than 5 cm should be absent from this analysis, many of the larger pieces broke after recovery and, hence, may be represented by smaller pieces. Also, since the field assessment of size was subjective, many pieces at or just under this limit were retained.

RESULTS

A total of 6,968 pieces of FBR weighing a total of 1,339.86 kg, was recovered from the processing area during the 1985 and 1986 field seasons. This represents an average of 124.4 kg per cubic metre of excavation area. A summary of the total weight and counts of FBR obtained from the various excavation areas is presented in Table 2 below.

Table 2. Summary of total count and weight of FBR recovered during 1985 and 1986 at DkPj-1.

	Non Sandstone		Sandstone		TOTAL	
Area	Count	Wt.(kg)	Count	Wt.(kg)	Count	Wt.(kg)
Block excavation	5083	866.84	978	252.88	6061	1119.72
Unit 43	266	82.9	119	73.35	385	156.25
Unit 4	292	34.2	15	3.49	307	37.69
Unit 48	206	24.45	9	1.75	215	26.2
TOTAL	5847	1008.39	1121	331.47	6968	1339.86

The focus of this analysis will be on the material recovered from the contiguous block excavation. The FBR recovered from unit 43 (a unit number applied to the feature discovered in the well trench) is discussed in the section detailing feature excavations. It should be noted that the relatively high amount of sandstone FBR in unit 43, compared to the others, is a result of the use of sandstone slabs to line feature 85-5. The FBR recovered from the completion of both unit 4, a unit started in 1983, and test unit 48 will not be dealt with further in this report, although it can be noted that the materials from these units are similar, in terms of lithic material, size range and condition, to those found previously in the processing area. No FBR was recovered from the spring channel excavations.

Size

In Figure 29, the FBR recovered from the block excavation has been summarized by size categories. As mentioned, some pieces smaller than 5 cm are present in this assemblage because of fragmentation of larger pieces and the retention of pieces nearly this size. The vast majority of the pieces of FBR recovered are under 10 cm in any dimension (n=5833; 96.2%). These FBR fragments represent highly fractured fragments of cobbles which most likely were subjected to several boiling episodes in order to be reduced to such small pieces. In contrast, by count there is almost no FBR larger than 15 cm (n=32; 0.5%), although the few large pieces recovered are

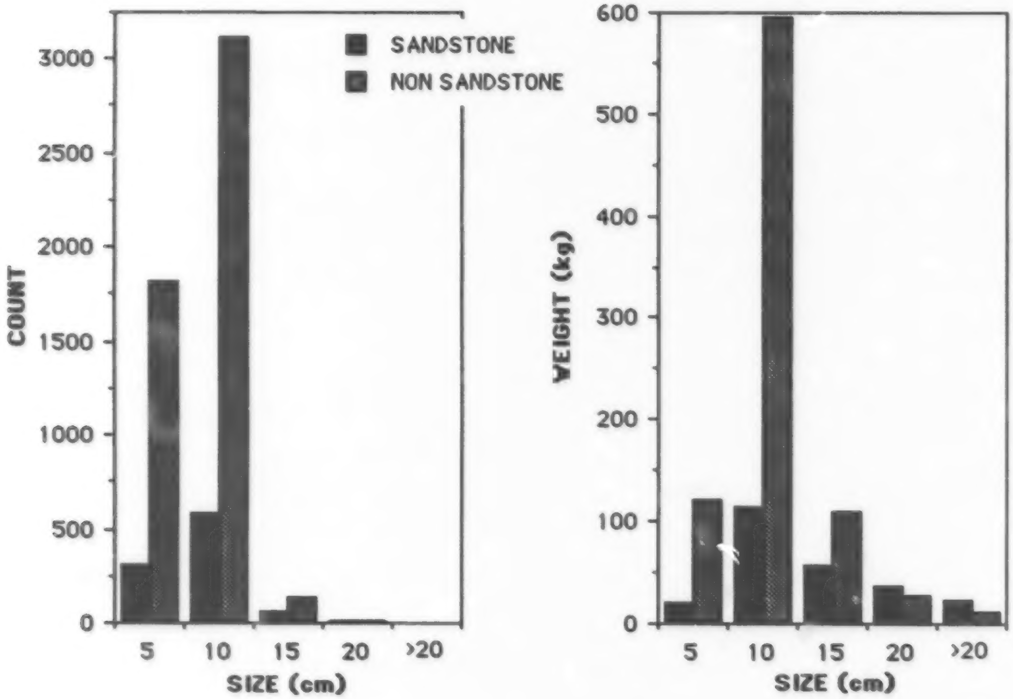


Figure 29. Summary of counts and weights by size categories of FBR recovered from the block excavation.

necessarily quite heavy and, thus, are more noticeable in the weight histogram of Figure 29. We interpret the bias in the size range of pieces of FBR from the block excavation as an indication that pieces under 10 cm represent unusable, discarded material, and the very low number of larger pieces is a result of the prehistoric recycling of FBR until it had exhausted its utility.

Figure 29 demonstrates that, for the most part, the ratio between sandstone and non-sandstone remains fairly constant, with the former making up about 20% of the assemblage. A notable exception, however, is in the two largest size classes of the weight histogram. The greater weight of sandstone in these size groups is believed to be related to the recovery of a number of large, heavy pieces of sandstone in the bottom of pit feature 85-4. Feature 85-4 is problematic, as the pit in some ways resembles a boiling pit. If this is the case, then the presence of large pieces of sandstone does not fit with our knowledge of the poor boiling properties of this rock type. It may be that this pit had multiple functions (see chapter on "Features").

Frequency and Distribution

We would expect that, if all FBR was simply discarded after use, discard areas would show a relatively uniform distribution of all sizes of FBR. Correlation coefficients obtained on the distribution of non-sandstone FBR of different size classes (Table 3) clearly indicate that there is very little correlation between the distribution of large (greater than 10 cm) and small (less than 10 cm) FBR . Distribution was obtained by using the 0.5 x 0.5 m provenience from the block excavation area with all levels combined.

Table 3. Correlation matrix of non-sandstone FBR size distributions in block excavation in DkPj-1.

SIZE(cm.)	5-10	>10
<5	.475	.29
5-10		.276

A better correlation exists between the two smallest size classes, but it is still lower than we would predict if all the FBR in both size classes was discarded uniformly. The relatively poor correlation between these smaller sizes may indicate that a useful size threshold occurs somewhere between 5 and 10 cm and that some of the larger pieces, those at or near the 10 cm size, were selectively picked up for reuse. Accordingly, it was observed that there was a more even distribution of small FBR across the excavation, but larger pieces tended to concentrate disproportionately in pit features (Table 4), where they would have been more quickly covered over by drifting soil and, thus, more likely to elude the scrutiny of those searching for reusable FBR during later uses of the site.

Table 4. Count of FBR by size in block excavation (unit 41 not included).

	Total Excavation Area		Features Only	
Size(cm)	Sandstone	Other	Sandstone	Other
<5	290 (32.0%)	1696 (35.1%)	47 (33.8%)	173 (34.9%)
10-15	543 (59.9%)	2954 (61.1%)	52 (37.4%)	278 (56.0%)
>15	74 (8.1%)	183 (3.8%)	40 (28.8%)	45 (9.1%)

Figure 30 illustrates in plan view the relative distribution of total FBR by weight for both lithic types recovered from the block excavation. The three areas of greatest FBR weight concentration correspond to the two pit features (85-4 and 85-6) and a rock-lined hearth (85-2) which retained the FBR in its functional context. The concentrations in these features are also reflected in the total FBR profiles shown in Figure 31. In these profile views, it can be observed that, apart from the concentrations displayed by the FBR in the pit features, the greatest weight of FBR was present in level 2 at a depth of 10-20 cm below the surface. The frequency count and weight decreased in the lower levels of the excavation. Generally, the bulk of the FBR was derived from a Late Prehistoric context; most was located above the sterile sand which was deposited roughly one thousand years ago. This corresponds to the period of heaviest use of the site.

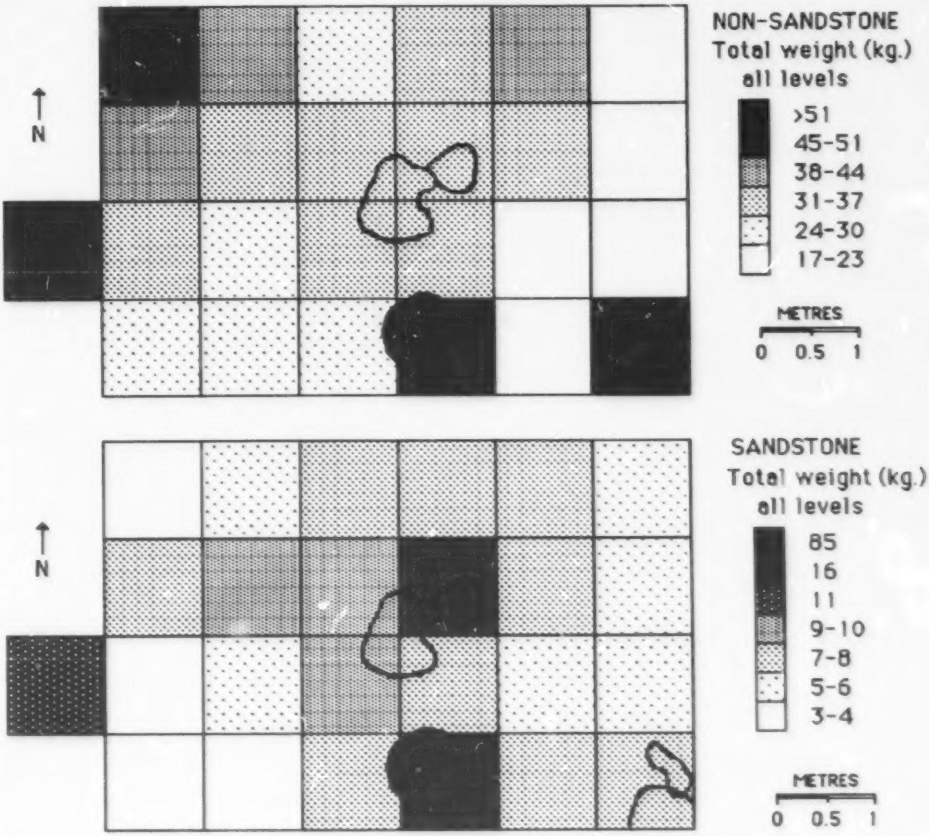


Figure 30. Plan views of block excavation comparing relative densities of sandstone FBR versus non-sandstone FBR by weight. (Note outlines of pit hearth features described in text.)

If the relative distribution of FBR has predictive value in terms of the location of nearby features, as suggested by the FBR distribution maps (Figures 30 and 31), it would appear that unit 41 is probably adjacent to a feature which could be expected to occur at a depth of between 10 and 30 cm below the surface. The sterile sand lens which occurred in the west end of the excavation, between 25 and 35 cm below the surface, does not show up very well in the FBR distribution maps. This is due to the recovery of FBR immediately above and below this lens from the two relevant 10 cm arbitrary levels in which this lens occurs. The gap in the FBR profile in level 3 of unit 50 can be attributed to this sterile lens.

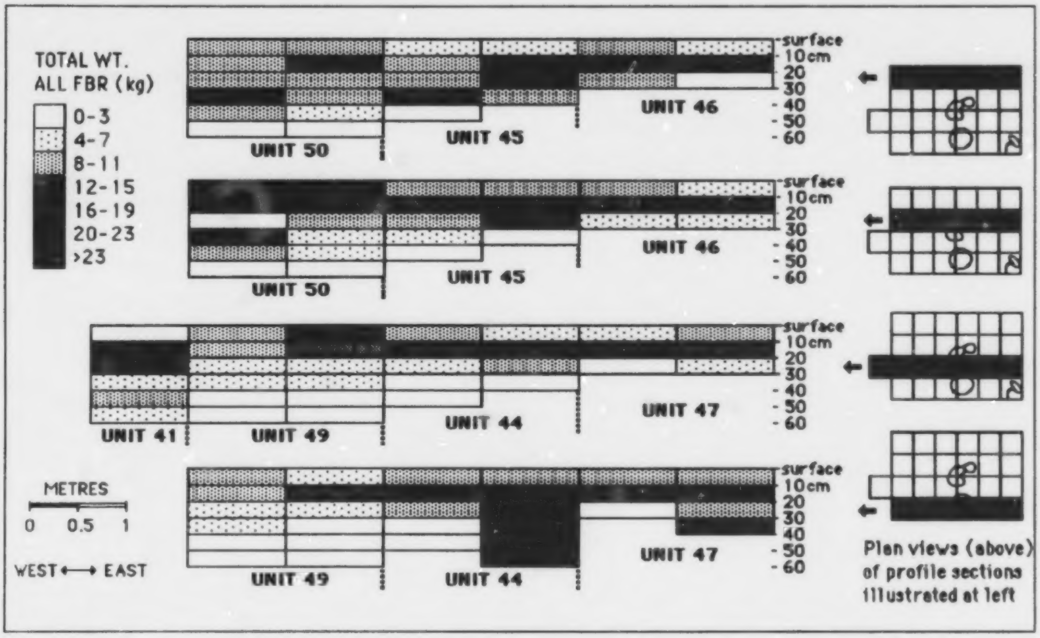


Figure 31. One metre section profiles of block excavation illustrating relative density of all FBR by weight.

Discussion

Although the mass of FBR recovered from the excavation is considerable, it is difficult to evaluate to what extent bone boiling was undertaken on the basis of FBR weight alone. For example, the 153.6 kg of FBR recovered from the fill of the largest pit feature (85-4) represents 14 % of the total recovered from the block excavation; however, this palls in comparison to the amount attributed to a single bone degreasing feature observed by Binford (1978:159) which contained almost 700 kg of boiling stone. In contrast, Schoolcraft has observed that the Sioux required only three or four stones the size of a 6 pound shot to boil meat (1852:176). As meat was usually boiled only enough to change the colour (Grinnell 1961:106), it would be expected that considerably less rock was required for cooking than grease rendering. An examination of the distributions of FBR in the block excavation (Figures 30 and 31) suggests that a significant proportion of the FBR from the adjacent units may actually represent associated discards from pit feature 85-4. It is also possible that features 85-1 and 85-2 may have been hearths used to heat some of the rocks used in 85-4.

There appears to be a marked discrepancy between the utilization of sandstone and non-sandstone, suggesting that these materials were used for different tasks, as our previous experimentation had predicted (Brink *et al.* 1986). Sandstone appears to have been used principally for lining hearths or roasting pits, as indicated by the almost exclusive use of this material for these applications in features 85-2 and 85-5. Non-sandstone, particularly quartzite, was apparently favoured for boiling, as suggested by the near exclusive use of this material in pit 85-6. The co-occurrence of these materials in the large pit, 85-4, might be an indication that this feature was not a grease rendering pit, but rather it was used alternately for steaming, roasting or boiling meat.

If the differing lithic material types were used for the same tasks, we would expect some correlation in the distribution of these materials in the excavation. When we compared the distribution of pieces of the two raw material categories outside of the pit features, however, a very low correlation was observed (r=.071). When the distributions of only the large FBR of each lithic group were compared, a low negative correlation was obtained (r=-.13). These results strongly suggest that the lithic types were discarded differentially, a fact which we attribute to the use of these materials for different tasks.

As to the overall purpose of the use of FBR at Head-Smashed-In, we concluded that the rocks almost certainly served primarily as boiling stones. Virtually all the rocks discovered in the course of excavation had been transported to their location of recovery, including the local bedrock material which was brought down slope to the processing area. In eliminating other possible uses of transported stone, it can be observed that there are no known cairns on the prairie below the jump; there are very few tipi rings; no effigies or other stone alignments have been observed; and rocks, by and large, were not used to form rings around the hearths discovered at the site. Rocks have been noted to form the lining around the basal edges of roasting pits, although this seems to be a limited function and one which often employed the local sandstone bedrock. In dismissing these potential uses, it remains that the prairie below the jump is virtually paved with stones, most transported from a distant source and exhibiting all the characteristic evidence of having been repeatedly heated and doused in a water bath. The conclusion that the rocks served primarily as stones to boil water seems inescapable. The most likely purpose for this activity would be to heat the contents of subsurface pits, boiling water to extract bone grease and cooking the contents of a meat and grease soup mixture.

These two tasks differ in that the former is directed at a future goal - the recovery of bone grease to be used in the preparation of storable foods, such as pemmican. The importance of fats in the prehistoric diet has been well documented by Speth (1983). If the operators of the jump were in immediate need of animal body fats, these would have been readily available from the immediately accessible fat depots, such as subcutaneous, intermuscular, kidney and body cavity fats. Thus, it seems reasonable to conclude that the rendering of bone grease, if indeed it was conducted at Head-Smashed-In, was done not out of need for fast access to body fats but rather for the purpose of future consumption. On the other hand, cooking of meat in a soup-like mixture of water and marrow or fats would have been done for consumption during the arduous butchering tasks. With the slaughter of a sizeable herd, even several hundred people would require several days to complete the butchering of the carcasses. Energy-rich foods, such as a grease/meat soup mix, would have been essential to maintain the work force. In attempting to explain the presence of enormous quantities of FBR at the site, it can be argued that there may have been a considerable need to prepare foods for immediate consumption and little need to render bone grease at that time and at that location.

While, as with all archaeologists dealing with an abundance of smashed bone and fire-broken rock, it is tempting to invoke grease rendering as the causal activity, the concerns raised above tend to mitigate against this conclusion. Furthermore, experiments by both Binford (1978) and ourselves (Brink *et al.* 1986) attest to the immense amount of labour associated with the rendering of grease from smashed bones. This begs the question of why such an investment of labour would be attempted when, following a successful communal kill, the hunters would be faced with an abundance of fat available from sources other than bone grease. Although the data on the quantitative amount of fatty acids available within the structure of bones are poor (Brink 1986), it seems fair to say that this fat depot represents one of the lowest components of available fats within the body of the large ruminants (Berg and Butterfield 1976:143-175). Even animals in nutritionally poor condition would have some fat stores in the other depots.

We are not questioning the need to render bone grease nor the importance of the uses for this substance, but it seems fair to ask if countless tonnes of rock would be hauled to the processing site to conduct an activity which was not required immediately and which could have been performed elsewhere at greater convenience to the hunters. If, as evidence suggests, the prairie below the Head-Smashed-In kill site was never a long-term camp site, and assuming such camps existed in the nearby Oldman River valley, then would it not be logical to haul the desirable bones to the more permanent camp sites for grease rendering? Wood fuel and boiling stones would have been available in abundance in the river valley.

Because the process of rendering grease from the structure of bison bones is destructive, it is difficult to identify direct evidence of this activity. Arguing by negative information, the absence of grease-rich bones from the assemblage, is not convincing. The presence of FBR and subsurface pits are likewise suggestive but not conclusive. In the faunal analysis section, we have discussed Morlan's attempts to identify the activity of smashing fresh bones through the microscopic examination of bone fragments recovered during fine screening. As noted, Morlan reports that, while a few of the Head-Smashed-In specimens exhibited the fracture features associated with green bone breakage, the vast majority have been reduced to their current size through taphonomic processes, primarily weathering (personal communication 1988). Hence, these data do not help substantially in delimiting the "signature" of bone grease rendering.

Thus the issue of the huge amounts of FBR recovered, and still to be recovered, from Head-Smashed-In remain an enigma. Undoubtedly, the rocks were fired until hot and subsequently used to heat a liquid probably contained in subsurface pits. Beyond this, the purpose of the activity has not been determined conclusively. Rendering grease from bones seems to be a likely use for hot rocks, yet this explanation raises other issues not easily reconciled. Perhaps foremost among these is the question of why the bones would not have been transported away from the kill to the convenience of the more permanent camps. From our admittedly biased perspective of labour efficiency, this would seem a more suitable solution than to haul enormous amounts of rock from the same source as the presumed location of the base camps. On the other hand, it may be that a prime use of the boiling stones was to cook foods for consumption during the butchering stage. Only further research will help resolve this issue.

In summary, over 6,968 pieces of FBR, weighing a total of 1,339.86 kg, were recovered from the 1985/86 excavations at the Head-Smashed-In processing area. The density of FBR recovered averaged 124.4 kilograms per cubic metre of excavation. The bulk of this FBR was recovered from the upper 30 cm of the deposit, a context roughly corresponding to the last 1,000 years of the use of the jump. If, as assumed, most of the thermally broken rock was used as boiling stones, this suggests that the activity for which the stones were used - rendering grease, cooking foods or other purposes - may have increased in importance during the later stages of the Late Prehistoric Period. Additionally, it points to increased use of the site during these later times.

That the great majority of thermally fractured rocks are non-local lithic types attests to the fact that considerable effort was made to transport hundreds of kilograms of rock from as much as 3 km from the site. Certainly, this must indicate a decided preference in the use of specific rock types for bison processing. At many sites on the Plains, FBR is treated by archaeologists as an item of little or no consequence. This tends to be especially true at prehistoric camp sites located on rivers or creeks where there is an inexhaustible supply of stones for cooking and boiling. The implicit assumption in many archaeological analyses seems to be that, with a huge, local source of rocks, there is little or no decision making involved in the selection, transport, use, and abandonment of stones for cooking; hence, there is little reason to focus archaeological attention on this material. We hope to demonstrate that at Head-Smashed-In, where this readily obtainable supply of quality cooking stones was lacking, FBR represents a significant and potentially instructive element of the archaeological record. We would argue that considerable attention was given to the differential properties of rock material types, to the efficient selection and transport of preferred rocks, and to the conservative use, caching and reuse of these scarce commodities. We further suspect that evidence of such decision making will be found at many other sites, even when supplies were more readily available.

CHAPTER 6

FAUNAL REMAINS

INTRODUCTION

The faunal remains from the 1985/86 excavations at Head-Smashed-In constitute a large and complex sample from diverse areas of origin. The full nature of the various samples will be described briefly before attention turns to the primary analytical data set - the material from the block excavation of the processing area - for a more complete description and discussion. The material from the spring channel excavations and fauna recovered from pit features within the block excavation also will be described in some detail and will be compared with the faunal remains from the processing area.

As expected, the faunal assemblage from Head-Smashed-In is overwhelmingly dominated by the remains of *Bison bison*. Non-bison materials were recovered in small amounts. Primarily, these consist of canids (dog, wolf and coyote), Richardson's ground squirrel and mule deer. Because the assemblages of these taxa are small, they will not be reported on here. Instead, as work continues every year at Head-Smashed-In, this assemblage will continue to grow and can be more profitably detailed in a future report. The following discussion will be directed at the bison bones recovered from the 1985/86 excavations.

PROCEDURES

Many of our field and laboratory procedures for the recovery and processing of faunal materials have been presented in previous published reports (Brink *et al*. 1985, 1986); however, as happens when one works repeatedly at a single site, procedures continue to be refined. Accordingly, a few updates are in order.

As before, faunal material is mapped and collected only if it can be assigned to a specific bison bone element or to a general class of elements, such as long bone fragments, vertebrae fragments, rib fragments and so on. The preservation of bone at the Head-Smashed-In processing area is generally so poor that tens of thousands of tiny bone fragments and bone dust are discarded each year. For specific reasons, such as to help quantify fragmentation, samples of these fragments are occasionally retained and processed.

The basic coding system for identifiable bison bones is still as presented in Brink *et al.* (1986:183). This is a modified version of an unpublished bison bone coding manual (Brumley 1980). A few minor changes to the system we published in 1986 have been incorporated for the results of the 1985/86 excavations. The categories recognized in our coding system, including the list of fragmentary remains, are given in Appendix 1. The basis of the coding system are the elements - the individual bones of the skeleton - and element portions - divisions of these specific bones (e.g., proximal, distal). Fragments, on the other hand, are specimens which cannot be assigned to a specific element but rather to a class of elements, such as long bones or vertebrae.

In addition to the identification of the element and element portion as presented in Appendix 1, the following observations are made whenever possible: the elements are sided as right, left, axial or unknown; an age estimate of fetal, immature, mature or unknown is made on the basis of degree of bone development and fusion; any observable modifications to the bone, such as cutmarks or green bone breaks, are noted; and associations and articulations are noted, as are bone tools. We do not record the particular number of an axial element, such as the 12th rib or 6th cervical, since this information can almost never be discerned given the fragmentary nature of the Head-Smashed-In assemblage. When bones are catalogued, a record is made of whether the catalogue entry is for a single bone, for multiple pieces of a single element, or for multiple pieces of numerous elements. This last category, referred to as "bulk material," offers very little potential for meaningful interpretation and has been omitted from all tables and charts presented in this section unless otherwise specified.

Finally, the condition of the bone as complete or incomplete is recorded. For this last variable, the important point is that badly broken bones can be recorded as complete if all of the appropriate element portions are present. As will be seen, except for carpals, tarsals, phalanges and sesamoids, few fully complete bones were recovered from the processing area at Head-Smashed-In. This variable, then, records if all of a distal humerus, a rib head or a skull petrous bone is present. This becomes important later in attempts to quantify minimum number of elements (MNE) and minimal animal units (MAU) present in the assemblage.

Throughout the remainder of this report, the standard measures of quantification will be NISP, MNE and MAU. The first category, being simply the number of all identified specimens, is perhaps the most common in faunal analysis, and the various strengths and weaknesses of using this measure have been discussed thoroughly (see Grayson 1978, 1979, 1984; Klein and Cruz-Uribe 1984). In this report, NISP will refer to all the bones which have been identified as to a specific element or to a general class of elements, such as long bone fragments. NISP counts do not include the material classified as "bulk entries" which consists of unidentifiable fragments. NISP will also be the most common measure used to compare the faunal material of HSI with other sites. This is out of necessity rather than preference, as NISP is the most common measure used by other researchers. Because the compared assemblages consist entirely of bison material, the relative percent of the total NISP which elements and elements portions make up will also serve as a basic measure of comparison.

Both MNE and MAU have become increasingly common means of communicating faunal assemblage composition. MNE simply counts the minimum number of times an element (metacarpal) or a portion of an element (proximal metacarpal) occurs in the assemblage. Fragments of elements or element portions are not included in the MNE counts. Thus, MNE differs from NISP in that the former will be a count of all elements or portions of elements which are essentially complete and therefore represent one specimen, while the latter counts all bones, however complete or fragmentary, which have been assigned to a particular element.

The MAU value counts the minimum number of times a bone unit of a once living animal occurs in the assemblage and differs from MNE in that the MAU value has been adjusted for the number of times a specific element or element portion occurs in the full skeleton. The MAU measure of assemblage composition was designed by Binford (1978) and subsequently refined by Binford (1984b) and Todd (1987).

No measure of assemblage quantification is flawless. The basis of Binford's calculation of MAU has been criticized by Grayson (1984:88-90).

Grayson's most serious concern is with the problem of fragmentation. He points out that, given the propensity of archaeological materials to be recovered in broken form, how is one to count the minimal animal units of 100 fragmented femora, for example? In this report, the MNE of an element was taken by recording only essentially complete elements or, more commonly, portions of elements. Thus, all of a distal humerus had to be present (a little erosion, scratches or surface reduction was allowed) for this to count as one MNE; a fragment of the articular condyle of this bone would be recorded as incomplete and would not be added to the total of the MNE count.

Given that fragmentation is extreme at Head-Smashed-In, Grayson's concerns are especially relevant to our analysis. Utilizing MNE and MAU values should help reduce the fragmentation effect on the NISP counts. Still, especially for comparisons with other sites, NISP values must often be used. As will be seen below, a dramatic reduction occurs when NISP values are converted to MNE and MAU values. This is a reflection of the very few numbers of complete element portions recovered. The unfortunate and unavoidable effect is that sample size is drastically reduced. However, while all of these quantitative measures are undoubtedly flawed and biased, in the final analysis one must choose some measure to communicate the results of the excavation, and these seem adequate for this purpose. In this report, when a bone is said to be "complete," it means that the specimen is essentially all of one of the elements or portion of an element listed in Appendix 1.

Finally, all catalogue entries were weighed; therefore, the weights pertain to the number of bones in each entry. Faunal data were then entered on Microsoft Excel to produce the catalogue and much of the basic information for the assemblage.

TAPHONOMY AND ASSEMBLAGE PRESERVATION

In previous reports on our work at this site, the generally poor preservation of the bone has been noted. The nature of bone preservation and condition is so critical to contemporary techniques of faunal analysis that it must be addressed again.

In preceding sections of this report, the very slow deposition of soil at Head-Smashed-In has been discussed. Because of the minimal rate of deposition, and presumably periodic erosion, cultural materials have certainly been exposed on the surface of the site for prolonged periods of time. Radiocarbon dates confirm that even after 1,000-2,000 years, faunal materials were buried only a few centimetres under the soil. Most bones probably were completely exposed for several hundred years before any significant degree of burial took place. The exceptions to this would be elements that found their way into gopher burrows and bones that were intentionally buried, such as those placed in subsurface pits. As has been noted previously, the 1985/86 excavation area was exceptional in that a greater degree of (and probably more rapid) burial took place in this part of the processing area than anywhere else so far discovered. Still, the situation for preservation is generally grim. The spring channel, on the other hand, offers an excellent environment for preservation. Fluvial deposition from the spring, combined with colluvial slump from the channel walls, have buried the faunal material deeply and probably quite rapidly.

As a result of prolonged exposure, faunal remains from the processing area have been subjected to a variety of adverse physical and chemical processes. Presumably, the dominant destructive agent has been physical weathering caused by exposure to sun, wind, rain and so forth. Repeated cycles of wet/dry and freeze/thaw would have been especially harmful to exposed bone. In addition, it can be assumed that the exposed materials were subjected to trampling by both the subsequent hunters as well as large grazing animals, such as bison, during the periods when the site was not in use. While trampling of fresh bone is demonstrably harmful (Behrensmeyer *et al.* 1986; Gifford-Gonzales *et al.* 1985), trampling of dry or already weathered bone would be even more destructive (see Andrews and Cook 1985). We believe that all of these forces have combined to render the Head-Smashed-In faunal sample an especially ravaged collection of bones.

There are a number of ways to examine the degree of preservation of the collection. One method commonly employed to measure of the degree of degradation of faunal material is the system of stages devised by Behrensmeyer (1978). According to her descriptions, the great majority of the faunal material recovered from the excavations at the processing area of Head-Smashed-In would fall into the later, more severe weathering stages. Specifically, Behrensmeyer's stages 4 and 5 seem to be applicable to the Head-Smashed-In fauna. Bone in stage 4 is described as weathered bone from which splinters may fall away and which has weathering cracks that penetrate into inner cavities. Stage 5 includes bone which is disintegrating *in situ*, with large splinters lying around what remains of the whole (Behrensmeyer 1978:151).

Typically at Head-Smashed-In, when a fairly large piece of a bison bone was preserved in what appeared to be one piece, closer inspection usually revealed that the bone was about to crumble if moved (Figure 32). Severe weathering, equivalent to Behrensmeyer's stage 4 or 5, was observed on most, although not all, of the large individual elements, such as limb bones, ribs, scapula, mandibles, skulls and pelves. Smaller bones and the dense, compact portions of larger bones, such as the articular surfaces, were notably better preserved. As would be expected, the faunal material recovered from a situation where burial was more rapid tended to be better preserved. Such was the case with bones recovered from within pit features and from the excavations near the head of the spring channel below the kill site.

Differential Preservation

A number of simple measures can illustrate the enhanced preservation of the faunal materials from areas of deeper and presumably more rapid burial at Head-Smashed-In. These include a number of records made at the time of cataloguing. The weight of individual specimens, the number of pieces of which each catalogue entry is composed, and the number and percent of catalogue entries which represent complete bones or, more commonly, complete element portions are all indicators of the condition of the assemblage.

To illustrate, of all the bones and bone portions recovered from the block excavation area, exclusive of features, some 32.0% were recorded as complete (entire bones or entire portions). In contrast, 49.2% of the bones recovered from within the features and 38.1% of items from the spring channel were complete. Similarly, bones from outside of features had an average weight of 35.7 g compared to 55.4 g for bones from features. The average weight of elements from the spring channel was 94.83 g. One

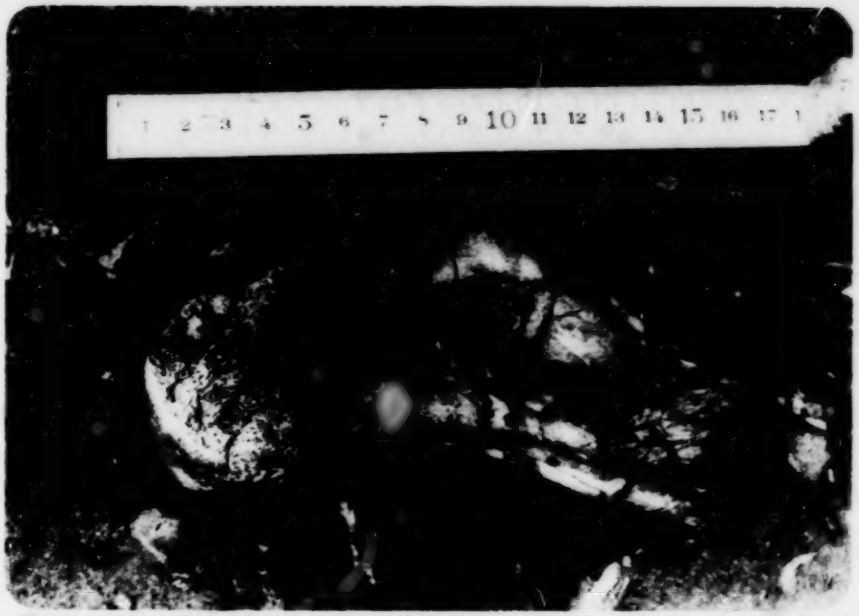


Figure 32. Distal humerus showing extreme stage of weathering.

further measure of the increased preservation of bones recovered from features is seen in the number of pieces which compose each catalogue entry. With features excluded, 79.2% of the bones recovered from the block excavation area were single piece catalogue entries. For elements from the features, this figure increases to 97.5% and to 96.5% for bones from the spring channel.

It is reasonable to suggest that some of these differences are a reflection of the different functions of the site and its components; that is, we would expect bones in the features to be quite different from bones in the general prairie surrounding these features. A number of quantitative measures, presented below, suggest that such is not the case, however. By and large, the assemblages from within the features and from the surrounding area are similar in most respects. The information on completeness is believed to reflect a true difference in the preservational environments of these two samples. On the other hand, it will also be shown that the nature of assemblage from the spring channel does differ quite dramatically in the same quantitative measures. This assemblage also differs in the kinds of bones most commonly recovered. Thus, the better condition of the bone could also be attributed to the nature of the the bones which compose this assemblage. In this case, simple measures, such as average weight of the specimens may say more about the kinds of bones being recovered than about the degree of preservation. Still, from visual inspection, it is clear that the spring channel material is far better preserved than the processing area material.

Thus, the bones recovered from within features and from the spring channel are more often complete, heavier, and more likely to be found in one piece than the general faunal assemblage recovered from the near surface of the processing area. In all cases, larger bones were in poorer condition. In contrast, the small, hard, dense carpals, tarsals, phalanges, sesamoids and similar elements were almost always in much better condition, and it was not uncommon to find them complete. This can be seen in Appendix 1 and Table 10 which, among other things, indicate the tendency of certain elements and portions of elements to be recovered in essentially complete form. The column "% MNE" in Table 10 is the percentage of each specific element or portion which was unbroken at the time of recovery. As can be seen, half or more of all the various carpals, tarsals and phalanges recovered from the processing area were in essentially complete condition. Larger bones were almost never fully complete, and portions of these larger bones were seldom complete.

Todd and Rapson (1988) have suggested a number of means by which the degree of fragmentation of various bison long bones can be quantified and compared. Unfortunately, several of their techniques cannot be applied to the Head-Smashed-In assemblage because there are simply too few complete long bones. A few of their measures can be applied, however. A method which they suggest is useful for recognizing patterns of differential destruction of long bone articular ends is a variation of one employed by Richardson (1980). The technique identifies those elements which have had one articular end preferentially destroyed. Bones that have a large percentage difference (i.e., many more specimens of one end of a long bone as opposed to the other end) have been subjected to the most severe destruction. Variation from a perfect 1:1 ratio of articular ends may be caused by either natural or cultural means and may be pre- or post-depositional. The technique illustrates differences: it does not determine causality.

Table 5 plots this information for the Head-Smashed-In data and for the Jones-Miller bison kill site. The latter site is used by Todd and Rapson

Table 5. Long bone fragmentation summary 1985/86 excavations, DkPj-1 (features and Jones-Miller site included).

ELEMENT	NO.COMP 1	FRAGS.(a) 2	PROXIMAL(b) 3	DISTAL(b) 4	MAX.(c) 5	%COMP.(d) 6	% DIFF.(e) 7	% Comp. Jones-Mill*	% Diff. Jones-Mill
Humerus	0	212	1	23	23	0	91.67	17.32	55.33
Radius	0	306	55	48	55	0	6.80	62.89	0.8
Metacarpal	8	149	46	47	55	14.55	0.92	72.76	2.95
Femur	0	163	5	0	5	0	100.00	17.02	13.25
Tibia	0	317	2	88	88	0	95.56	22.7	21.55
Metatarsal	0	247	43	59	59	0	15.69	54.87	0.73

(a): All portions of limb elements NOT cataloged as complete proximal or distal ends
(b): Includes proximal and distal ends cataloged as complete
(c): Maximum element count= complete plus the greater of proximal or distal ends from columns 3-4
(d): Percentage of complete elements=

$$\frac{\text{Col. 1 X 100}}{\text{Col. 5}}$$

(e): Percentage difference between counts of proximal and distal ends =

$$\frac{([\text{Col. } 1 + \text{Col. } 3] - [\text{Col. } 1 + \text{Col. } 4])}{(\text{Col. } 1 + \text{Col. } 3) + (\text{Col. } 1 + \text{Col. } 4)} \text{ X } 100$$

* Data from Todd and Rapson (1988)

(1988) as an example of a badly fragmented and scattered assemblage. It can be seen that the "%Diff." is extremely high for the humerus, femur and tibia, indicating a great difference in the preservation of opposing articular ends. This may suggest preferential selection and destruction of these portions for grease rendering or similar selection by carnivores or natural deterioration.

In contrast, metacarpal articular ends from Head-Smashed-In are preserved in nearly equal numbers (%DIFF. =0.92). It is interesting that this was the only complete long bone found during the 1985/86 excavations and that it was also the most commonly complete leg bone, as well as the bone with the lowest "%Diff." from Jones-Miller. The nearly equal numbers of proximal and distal metacarpal portions may indicate that neither end was highly valued for intensive processing, such as grease rendering (or that both ends were equally valued). Again, natural agents may have been responsible for the ratio of ends recovered in the assemblage.

Another method Todd and Rapson (1988) suggest for estimating the degree of carnivore damage to an assemblage is a comparison of the differential representation of articular ends of the humerus and tibia. Based on work by Binford (1981), the technique employs the fact that the opposing ends of these two long bones have marked differences in survival potential and are among the most commonly gnawed by carnivores. Assemblages with a high proportion of distal to proximal ends have been seriously damaged by carnivores, while an even representation of the two suggests a lack of gnawing.

Figure 33 plots the "% Difference" as calculated from Table 5 for the Head-Smashed-In humeri and tibiae, as well as the values for several other Plains bison kill sites as taken from Todd and Rapson (1988). As is readily apparent, the Head-Smashed-In assemblage is located in the extreme area of differential articular end destruction. For these two elements, proximal ends are almost non-existent, with distal ends making up nearly the entire sample. At the other extreme is the Olsen-Chubbuck site (Wheat 1972) where the representation of opposing long bone ends is nearly equal. This is probably due to the fact that many of the bison killed in the deep arroyo were never butchered and, thus, were inaccessible to both man and carnivore. Other kill sites are located between these two extremes. The suggestion derived from Figure 33 is that the Head-Smashed-In assemblage is extremely ravaged; however, the cause of this damage remains unclear. Since there is good evidence that bison butchering changed considerably from Palaeo-Indian to Late Prehistoric times, especially in the amount of bone processing which occurred (Frison 1982; Kelly and Todd 1988), it may seem that Figure 33 illustrates this change as much as it does assemblage destruction. It seems unlikely, however, that this factor alone could account for the extreme degree of difference between Head-Smashed-In and all other sites. Unfortunately, most published reports on other Late Prehistoric bison kills do not contain the information needed to calculate the Todd and Rapson formula.

Todd and Rapson (1988) note that, at many Plains bison kill sites, both the forelimbs and hind limbs exhibit a tendency for the fragmentation index to decrease distally. The Head-Smashed-In data exhibit the same pattern;

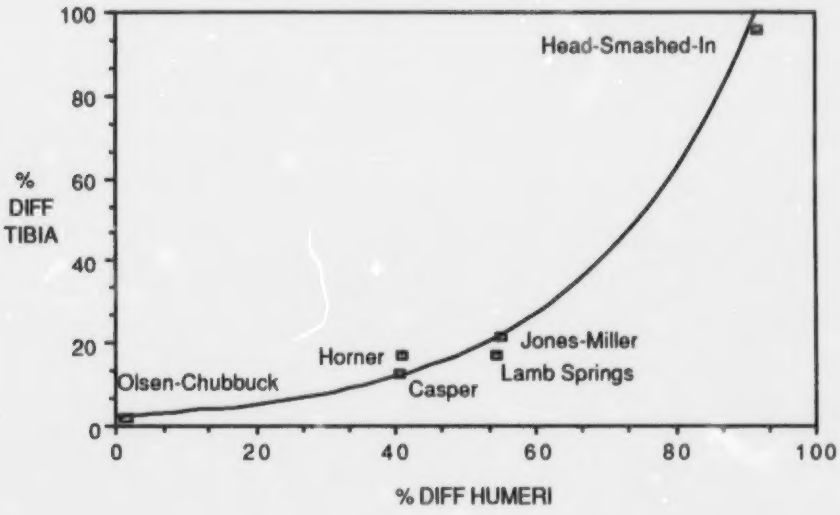


Figure 33. Differential preservation of proximal and distal ends of humeri and tibiae at Head-Smashed-In and other bison kill sites. Modified from Todd and Rapson (1988).

that is, the highest percent difference values (Table 5) are associated with the most proximal bones. When the minimum number of elements (MNE) for the Head-Smashed-In limb bones are plotted from proximal to distal across the X-axis of Figure 34 the general trend towards increasing representation of distal elements is apparent.

Todd and Rapson (1988) suggest that this tendency, along with the general trend towards great variation in frequency of opposing articular ends, is likely indicative of a significant amount of carnivore modification to the assemblage. This conclusion seems to be based, in part, on Binford's (1981) assertion that a wide variation in the numbers of proximal versus distal ends, especially for the humerus and tibia, suggests intensive carnivore gnawing. While Todd and Rapson (1988:313) stress that the techniques described above document only differential destruction and do not directly indicate processes responsible for the observed differences, they nevertheless state repeatedly that carnivore action was the agency responsible for the patterns observed at Plains bison kill sites.

While this is entirely feasible, it is no more a proven explanation for the observed faunal record than are explanations based on the natural

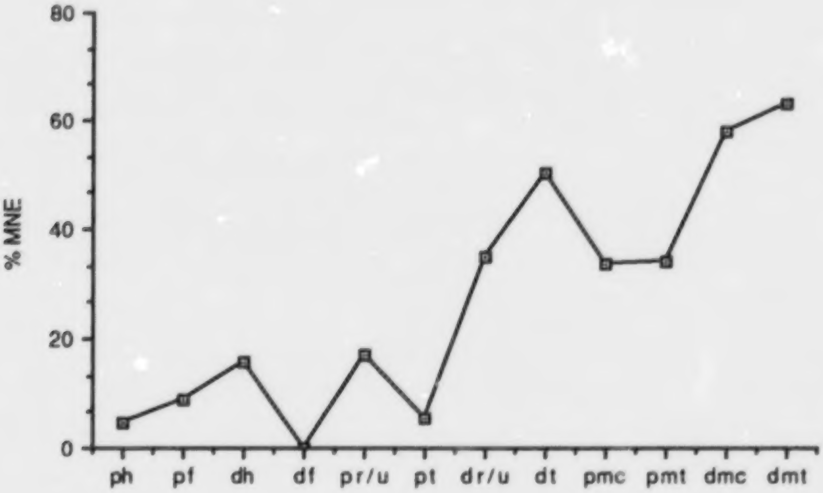


Figure 34. % MNE of limb bones, proximal to distal, from DkPj-1.

decay or the cultural processing of these same bones. Note, for example, the bulk density values (Table 6) for the long bones of deer as provided by Lyman (1985). Similar figures are not yet available for bison, but we suspect that the relative rank of least and most dense bones would not change substantially for bison. Density increases distally in the fore and hind limbs. Thus, distal elements and element portions are more likely to survive than are proximal elements. Lyman (1982) has documented the relationship between bone density and survivability. Less dense bones will be more susceptible to natural deterioration through chemical and physical erosion. It likely that, left entirely alone for natural decay to occur, skewed ratios of articular ends would mimic those suggested for carnivore damage.

Along with bulk density, Table 6 gives the percentage of fat contained in the articular ends of bison limb bones and the volume of each articular end. How these - and other measures of bone marrow - of modern bison were made is described in detail below, and the complete results of these studies is presented. For the moment, the mean figures presented in Table 6 suffice to assist in the examination of differential faunal preservation.

The data in Table 6 reveals a strong relationship between the bulk density of a bone, as recorded by Lyman (1985), and the relative amount of

Table 6. Bulk density of deer bones and percent fatty acids and volume of articular ends of bison limb bones.

Element	Bulk Density*	Mean % Fatty Acids	Mean Vol.(ml) Articular End
Proximal Humerus	0.24	40.50	596.25
Distal Humerus	0.39	22.00	291.44
Proximal Radius/Ulna	0.36	33.50	127.50
Distal Radius/Ulna	0.43	25.70	193.50
Proximal Metacarpal	0.56	8.90	76.00
Distal Metacarpal	0.49	15.20	95.91
Proximal Femur	0.36	31.40	358.00
Distal Femur	0.28	35.20	529.25
Proximal Tibia	0.30	33.50	289.00
Distal Tibia	0.50	14.10	86.67
Proximal Metatarsal	0.55	12.40	60.00
Distal Metatarsal	0.46	22.70	88.40

* Bulk density data from Lyman (1985).

fatty acids present in each limb bone. This relationship is graphed in Figure 35. As can be seen, the bones lowest in fatty acids are those with the highest bulk density, while those with the greatest amount of fats are the least dense. This is to be expected, as the least dense bones will have more space among the bone tissue to store fats. It can also be seen that, with a few exceptions, the bones highest in fat content are also the more proximal elements.

A fairly clear relationship also exists between the bulk density of the limb bones and the volume of the articular ends. This relationship is plotted in Figure 36. Although not as linear as the relationship between density and percentage fatty acids, it is clear that bones with the greatest volume are the least dense, and those with the smallest volume have the highest density values. Presumably, bones with the largest mass also have the greatest amount of available space between the bone tissue, thus reducing bone density. The proximal to distal trend is also noted with decreasing bone volume. It should be restated that density for deer bones is being compared to anatomical data for bison, and it is possible that bison bone density will yield different results.

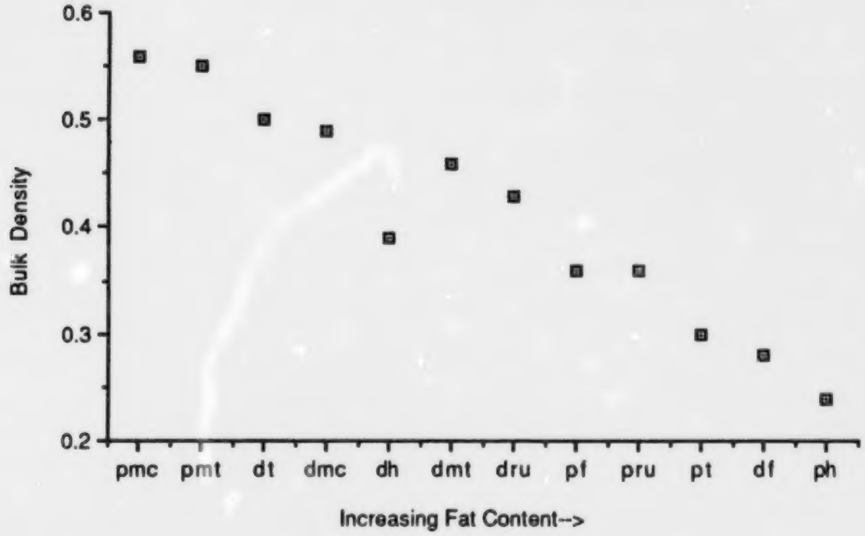


Figure 35. Relationship between bulk density and fatty acid content of modern bison leg bones (density data from Lyman 1985).

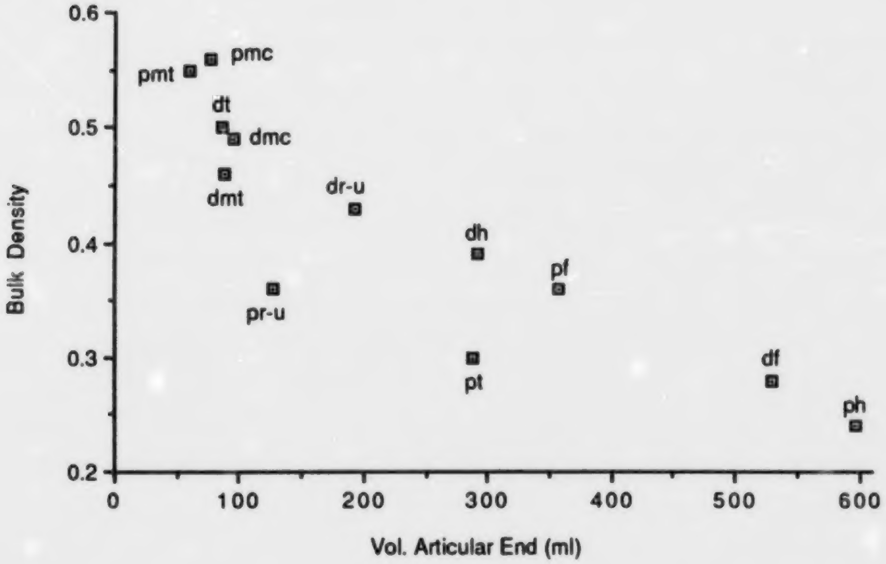


Figure 36. Relationship between bulk density and the volume of articular ends of bison leg bones (density data from Lyman 1985).

The important point demonstrated by Table 6 and Figures 35 and 36 is that the articular ends with the greatest amount of fat, the greatest volume and the lowest density all exhibit a tendency to decrease distally. Thus, if cultural processing of faunal material proceeded with the objective of obtaining the maximum amount of nutritional value with the least amount of work, then the representation of various articular ends in the archaeological record would likely mimic the patterns suggested by Todd and Rapson (1988) and Binford (1981) as indicative of carnivore destruction. Furthermore, natural decay, excluding any carnivore action, would also preferentially select for a preponderance of distal elements over a period of time.

In the real world, people butchered animals, threw away some bones, processed others, and left the site to the waiting carnivores who chewed on some bones and ignored others. Finally, natural decay began on the remains. Throughout these events, the density of different bones, the amount of fat in each bone and the size of the articular end influenced the actions of all the potential destructive agents. In the recent trend to cast doubt on the validity of human modification of faunal assemblages (e.g., Binford 1981, 1984a, 1984b), it has become increasingly popular to promote the influence of non-human taphonomic agencies as faunal modifiers (e.g., carnivores) when sometimes there is no more evidence in support of these agents than there is for human action or for natural decay. Todd and Rapson (1988), Binford (1981) and others are fully aware of the necessity for direct evidence of carnivore modification, such as tooth marks, puncture holes and so forth. In the absence of these, however, the single criteria of differential long bone articular end frequencies is insufficient to conclude the importance of carnivore damage to the assemblage.

The search for direct evidence of carnivore action in the Head-Smashed-In assemblage leaves one frustrated. Faunal analyst, Jean Wright, examined all the catalogued specimens from the 1985/86 excavations of the block area and the spring channel for evidence of carnivore damage on the bone surfaces. Of thousands of specimens examined, a total of eight bones was singled out as exhibiting marks which possibly or probably could be attributed to the actions of carnivores. The extreme weathering of the bone surfaces undoubtedly has obliterated whatever traces of this activity may have once been present. Accordingly, it is difficult to assess the degree of degradation caused by carnivores as opposed to other agencies. It is tempting to suggest that, because of the massive amounts of bone left at communal kills and the attraction this would have held for local carnivores and because of the very slow burial of abandoned faunal material at Head-Smashed-In, carnivore activity would have been extreme. This is suggested by the position of Head-Smashed-In in Figure 33, as well as by other aspects of differential preservation described above.

The fact remains, however, that this logical probability cannot be demonstrated given the data at hand. In addition, it should be remembered that the remains under study originate from a kill/butchery site which appears to be among the most heavily utilized on all of the northern Plains. It is by no means ruled out that, at least for some of the many uses of the jump, the prehistoric inhabitants were indeed responsible for the nearly complete utilization of the carcass portions, leaving a bone residue of small, hard, low food value elements that may be essentially indistinguishable from a hardly processed assemblage left on the site surface to the ravages of all forms of degradation.

In summary, the 1985/86 faunal assemblage from Head-Smashed-In is largely in a state of very poor preservation. This is slightly less true for bone recovered from the few units excavated in the spring channel and from within subsurface pit features excavated in the processing area. In these two latter contexts, the materials almost certainly have been covered over with wind-blown or stream-deposited soil and more rapidly removed from some of the severe taphonomic processes that occur on the site surface. Yet even the bone recovered from these contexts could hardly be described as being in good or excellent condition. The great majority of bone from all areas is highly weathered and badly fragmented. Complete elements are almost entirely restricted to small, dense bones, such as carpals, tarsals and phalanges.

The processes that have caused this severe degradation are unknown. It is probable that carnivores caused extensive damage to the assemblage. Likewise, natural erosion through physical and chemical weathering almost certainly ravaged the fauna. Finally, human processing would be expected to have modified the sample. Unfortunately, it is difficult or impossible to distinguish between these causal agents, especially since some of the diagnostic evidence, such as carnivore marks, are not preserved on the surface of the bones. Furthermore, it has been suggested above that all of these potential modifiers of the assemblage may have left essentially the same residue. Human hunters, carnivores and natural decay all tend to favour the early removal from the sample of less dense, nutritious bones and the retention of dense, relatively worthless elements. There is no easy solution in sight for a quick, unambiguous method of determining the relative importance of each of the faunal modifiers at Head-Smashed-In. Some evidence of human alteration, such as cutmarks and green bone fractures, have been documented and will be presented later in this report.

RESULTS OF THE 1985/86 EXCAVATION

Excavating at the Head-Smashed-In processing area is much different from excavating the classic Plains bison kill sites. There are no complete or partially complete skeletons. Among the thousands of bones recovered, there are virtually no articulated elements. Occasionally, a few phalanges, carpals or tarsals are found in close proximity, suggesting that they belonged to a single animal; however, the vast bulk of the material is a widespread but dense scatter of isolated elements and element portions. Thus, there is no discussion of "butchering units" or other associations of faunal elements other than by location, such as within features. Also, except in the features chapter, there are no maps of the bone distribution. Although all identifiable bone was mapped at the time of recovery, no distributional information has been noted except for feature concentrations; that is, the dense scattering of bone appears as an homogeneous blanket across the site. So dense are the bone maps that we have not yet discovered a method of reducing a large number of one metre square bone distribution maps onto a single page, or several pages, while keeping the identifications legible. To split the maps onto many pages negates the attempt to show distributional information. The following discussion of necessity will be limited to the kinds of comments that can be advanced for an assemblage of scattered, disarticulated elements.

In total, over 8,000 individual bison bones were catalogued from all 1985/86 excavations. It should be remembered that many of these specimens were broken into several pieces, and some of the catalogue entries consist of bulk entries of bone fragments, sometimes consisting of dozens or hundreds of bones. Thus, the actual count of bone pieces recovered is much higher than the catalogue total. The great majority of catalogued specimens, including bulk material (7683; 91.5%), originated from the block excavation at the processing area. Of the remainder, 584 (6.9%) came from the excavations in the upper portions of the spring channel; 46 (0.5%) were recovered from the completion of the excavation of unit 4 begun in 1983 and reported in Brink *et al.* (1985); and 88 (1.0%) came from the testing of a slight depression on the prairie (unit 48) suspected of being some form of pit feature. These latter two samples will be discussed only briefly below.

Unit 4

Unit 4 was a 2 x 2 m unit placed near the presumed centre of the processing area below the jump off (see map, Brink *et al.* 1985:64). Due to the great amount of material contained in this unit, and to excavation commitments relating to the development of the interpretive centre, only level 1 and part of level 2 were completed in 1983. The unfinished unit had been covered with plastic and soil in the intervening years. The unit was completed in 1985. The sample of faunal material from the final excavation is very small - 44 bone pieces within 23 catalogue entries - and does not merit further discussion or analysis. For the record, Table 7 presents the list of identified bison bones from the final two levels of unit 4. In any future analysis, it would be most appropriate to add this material to the faunal remains already reported on in Brink *et al.* (1985).

Unit 48

In a similar fashion, a small excavation was conducted in 1985 of a slight depression observed on the prairie to the north side of the spring channel (Figure 3). It was speculated that this depression could be the remains a collapsed pit feature, and it was decided to section the depression with a 0.5 x 1.5 m trench. The surface deposits were shovel shaved, and the walls were examined for evidence of a pit. No such evidence was observed, and it quickly became apparent that the depression was likely of natural

Table 7. Fauna, DkPj-1 1985 excavation, Unit 4 completion.

UNIT	QUAD	SQD	LEV	CATG *1	ELEMENT	PORTION	COND *2	SIDE	AGE	COUNT	WT
4	4	4	2	MSB	skull	tooth row	F	?	M	18	131.2
4	4	3	2	MSB	skull	petrous	F	?	?	2	10.6
4	3	4	2	SB	cerv vert	centrum	F	A	I	1	32.5
4	4	4	2	MSB	rib	body	F	?	?	2	12.1
4	4	1	2	SB	unciform	n/a	C	L	?	1	14.3
4	3	4	2	SB	magnum	n/a	C	R	M	1	19.6
4	4	4	2	SB	femur	distal end	F	L	I	1	32.6
4	2	2	2	SB	tibia	shaft	F	R	?	1	19.7
4	1	2	3	SB	navic cuboid	n/a	F	L	?	1	9.6
4	4	1	4	SB	metatarsal	prox end	C	L	M	1	13.8
4	4	4	2	SB	metapodial	distal end	F	?	I	1	15.1
4	4	4	2	SB	metapodial	distal end	F	?	?	1	5.5
4	4	2	2	SB	metapodial	distal end	F	?	?	1	16.3
4	4	4	2	SB	1st phalanx	n/a	F	?	?	1	10.6
4	4	2	2	SB	prox sesamoid	n/a	C	L	?	1	5.4
4	3	4	2	SB	prox sesamoid	n/a	C	?	M	1	20.3
4	4	1	2	SB	prox sesamoid	n/a	C	L	?	1	4.4
4	4	3	2	SB	2nd phalanx	n/a	C	?	?	1	24.3
4	2	2	2	SB	long bone frag	n/a	F	?	?	1	8.4
4	2	1	2	BLK	long bone frag	n/a	F	?	?	3	93.6
4	4	1	2	BLK	long bone frag	n/a	F	?	?	3	86
4	1	2	2	SB	vert frag	n/a	F	A	?	1	7.8
4	1	2	3	SB	vert frag	n/a	F	A	?	1	8.6

*1: SB= One piece of a single bone
MSB= Multiple pieces of a single bone
BLK= Bulk catalog of numerous bone element fragments

*2: C= A complete bone element or element portion
F= An incomplete element or element portion

origin. Nevertheless, this small area, like all areas for hectares around the base of the jump, contained some faunal material. Seventy-four catalogue entries for 88 bone fragments were made for this test. Again, for the record, the list of elements recovered from the trenching of unit 48 is presented in Table 8.

The Block Excavation

The bison remains recovered from the 1985/86 block excavation area will be discussed from a number of perspectives: the entire assemblage from all units, the fauna from all features, and the assemblage from the stratified area only of the block excavation. Despite the cautionary notes discussed above, regarding the poor condition of the fauna and the inability to ascertain causal agents in the modification of the sample, it is still correct to state that this collection of material is the best yet recovered from

Table 8. DkPj-1, Unit 48 1985 excavation.

UNIT	LEV	CATG *1	ELEMENT	UNIT	COND *2	SIDE	AGE	COUNT	WT
48	1	SB	skull	basio-occipital	F	?	?	1	19
48	1	SB	cerv vert	centrum	F	A	I	1	47
48	1	SB	cerv vert	centrum	F	A	?	1	19.4
48	1	SB	lumbar vert	centrum	C	A	I	1	55.5
48	1	SB	lumbar vert	vert project	F	A	?	1	10.7
48	1	SB	pelvis	acetabulum	F	R	M	1	82.5
48	1	SB	pelvis	acetabulum	F	L	?	1	20.2
48	1	SB	pelvis	acetabulum	F	R	?	1	27.3
48	1	SB	scapula	glenoid cavity	F	?	?	1	41.6
48	1	SB	scapula	anteriot border	F	?	?	1	28.5
48	1	SB	scapula	blade	F	?	?	1	8.5
48	1	SB	scapula	crest	F	?	?	1	7.2
48	1	SB	humerus	distal end	C	L	M	1	94.5
48	1	SB	humerus	distal end	F	L	?	1	27.6
48	1	SB	radius	distal end	C	L	I	1	51.1
48	1	SB	lunate	n/a	C	R	M	1	12.9
48	1	SB	magnum	n/a	C	R	M	1	16.2
48	1	SB	magnum	n/a	F	?	?	1	8.9
48	1	SB	scaphoid	n/a	F	R	?	1	15.3
48	1	SB	scaphoid	n/a	C	L	M	1	28.2
48	1	SB	unciform	n/a	C	L	M	1	11.1
48	1	SB	metacarpal	complete	C	L	M	1	207.5
48	1	SB	metacarpal	distal end	C	?	M	1	88.3
48	1	SB	patella	n/a	F	?	?	1	26.7
48	1	SB	tibia	distal end	F	?	I	1	67.7
48	1	SB	tibia	distal end	C	L	M	1	67.7
48	1	MSB	tibia	shaft	F	?	?	4	166.7
48	1	SB	tibia	shaft	F	?	?	1	27.5
48	1	SB	tibia	distal end	F	?	?	1	8.4
48	1	SB	astragalus	n/a	F	R	M	1	53.1
48	1	SB	astragalus	n/a	F	R	M	1	100.1
48	1	MSB	calcaneus	n/a	F	R	M	2	79.6
48	1	MSB	calcaneus	n/a	F	L	M	2	40.3
48	1	SB	cuneiform pes	n/a	F	?	?	1	7
48	1	SB	lat malleolus	n/a	F	L	?	1	6.1
48	1	SB	metatarsal	distal end	C	?	M	1	77.6
48	1	SB	metatarsal	distal end	C	?	M	1	79.3
48	1	SB	metatarsal	proximal end	C	R	M	1	26.9
48	1	SB	metatarsal	proximal end	F	?	M	1	24.2
48	1	SB	metapodial	distal end	C	?	M	1	41.3
48	1	SB	metapodial	distal end	C	?	M	1	20.9
48	1	SB	metapodial	distal end	F	?	?	1	10.5
48	1	SB	metapodial	distal end	F	?	?	1	16.4
48	1	SB	metapodial	distal end	F	?	?	1	16.2
48	1	SB	metapodial	distal end	F	?	I	1	17.9
48	1	SB	metapodial	distal end	F	?	I	1	13.2
48	1	SB	metapodial	distal end	F	?	M	1	21.7
48	1	SB	metapodial	distal end	F	?	?	1	5.7
48	1	SB	metapodial	distal end	F	?	?	1	6.4
48	1	SB	metapodial	distal end	F	?	?	1	3.1
48	1	SB	1st phalanx	n/a	F	?	M	1	18.9
48	1	SB	1st phalanx	n/a	C	?	M	1	29.4
48	1	SB	1st phalanx	n/a	F	?	M	1	14.4
48	1	SB	2nd phalanx	n/a	F	?	M	1	13.9
48	1	SB	2nd phalanx	n/a	F	?	M	1	9.1
48	1	SB	2nd phalanx	n/a	F	?	M	1	15.1
48	1	SB	2nd phalanx	n/a	F	?	M	1	12.3
48	1	SB	2nd phalanx	n/a	F	?	M	1	4.3
48	1	SB	2nd phalanx	n/a	F	?	M	1	5
48	1	SB	2nd phalanx	n/a	F	?	M	1	8.8
48	1	SB	3rd phalanx	n/a	F	?	M	1	3.7
48	1	SB	prox sesamoid	n/a	C	?	?	1	2.2

Table 8. continued

UNIT	LEV	CATG *1	ELEMENT	UNIT	COND *2	SIDE	AGE	COUNT	WT
48	1	SB	prox sesamoid	n/a	C	?	M	1	7.2
48	1	SB	dist sesamoid	n/a	C	?	?	1	2
48	1	SB	low mol/prem	n/a	F	?	M	1	45.2
48	1	SB	low mol/prem	n/a	F	?	M	1	23.4
48	1	SB	upper tooth	n/a	F	?	M	1	29.4
48	1	SB	upper tooth	n/a	F	?	M	1	33.8
48	1	SB	upper tooth	n/a	F	?	M	1	49.9
48	1	SB	upper tooth	n/a	F	?	M	1	52.5
48	1	SB	upper tooth	n/a	F	?	M	1	11.2
48	1	BLK	vert frag	n/a		A	?	3	21.3
48	1	BLK	long bone frag	n/a		?	?	2	139.2
48	1	BLK	rib frag	n/a	F	?	?	7	70.4

*1: SB= One piece of a single bone element
MSB= Multiple pieces of a single bone element
BLK= Bulk catalog of numerous bone element fragments

*2: C= A complete portion of bone element or element fragment
F= An incomplete element or portion of element

excavations at the Head-Smashed-In processing area, and it is likely to remain so for many years to come. Subsequent to the completion of the 1986 excavations, the focus of activity shifted to an area of the site farther north, out of the small depositional basin, and back into areas with deposits similar to those encountered in 1983 and 1984, that is, seldom or never extending below 20-25 cm below surface. Thus, it is important to examine the 1985/86 assemblage in some detail, in the search for patterns or regularities which may typify bison processing at communal kill sites.

To reiterate briefly, the contiguous excavation area referred to as the block consists of an area of 25 square metres. Included in the faunal analysis of the block area is the material recovered from unit 43, the excavation at the nearby well head where Feature 85-5 was encountered. The number and configuration of the excavation units is shown in Figure 3. As noted, much of the excavation area was characterized by cultural deposits extending no more than 25 cm below surface. However, the western end of the excavation, including units 41, 49 and 50 and quadrants 1 and 2 of unit 45, revealed artifacts to a maximum depth of 45-50 cm below surface. In addition, within this deeper deposit, there was faint but unmistakable evidence of stratification of the soil and artifacts. This area of 11 square metres has been designated the stratified block. The total volume of excavated area from the stratified region amounts to 5.5 cubic metres, or 61.1% of the entire block excavation. The non-stratified areas amount to 14 square metres but because of the shallow deposits only 3.5 cubic metres or 38.9% of the excavated volume. The following information pertains to all fauna from the 25 square metre block excavation area. Later, the fauna from the stratified area alone will be examined.

The following discussion is based upon all bison remains recovered from the contiguous excavations of the block area. This includes the samples recovered from within designated features, but it excludes the items catalogued as bulk. The latter are lot bags of multiple, unidentifiable bones which have little analytic value. The bulk remains are reported in Table 9 but are not discussed further. As bison processing features - hearths, boiling pits, roasting pits and so on - make up an important component of our discoveries at Head-Smashed-In, these will be examined separately from the remainder of the assemblage. One would suspect that certain faunal elements will preferentially find their way into the features for reasons which have to do with the function or purpose of the feature. Inter-assemblage comparisons will permit evaluation of this suspicion.

NISP and Assemblage Composition

The full 1985/86 faunal record, including the features, recovered from the block area is presented in Appendix 1. This table shows the total NISP count for each major skeletal element, as well as the count for all recognized portions of these elements and for those items classed as fragments. A shortened version of this information, which presents only the NISP count of the major elements and not the element portions, is included here as Table 10. This table also provides the count and percentage of each element, and of certain classes of fragments, by level and for all levels combined. It will be recalled that most excavation units in the block area were essentially sterile beyond a depth of 20-25 cm. However, some units in the stratified area contained cultural layers that extended to 50 cm below surface, and some pit features extended beyond this depth. Hence, the table includes records of a few bones in levels 5 to 7.

Throughout this discussion, the assemblages recovered from the 1985 and 1986 seasons have been combined. This is to be expected, given the contiguous nature of the excavation units; however, it is worth noting that

Table 9. NISP DkPj-1 bulk entries only, 1985/86 excavations.

ELEMENT	85/86 NISP #	85/86 NISP %
Skull	4	2.88
Mandible	2	1.44
Hyoid	0	0.00
Atlas	0	0.00
Axis	0	0.00
Cervical vert	0	0.00
Thoracic vert	5	3.60
Lumbar vert	1	0.72
Sacrum	0	0.00
Caudal vert	0	0.00
Rib	30	21.58
Sternabra	0	0.00
Pelvis	4	2.88
Scapula	10	7.19
Humerus	3	2.16
Radius	2	1.44
Ulna	12	8.63
Scaphoid	0	0.00
Lunate	0	0.00
Cuneiform	0	0.00
Pisiform	0	0.00
Magnum	0	0.00
Unciform	0	0.00
5th Metacarpal	0	0.00
Metacarpal	2	1.44
Femur	5	3.60
Patella	0	0.00
Tibia	43	30.94
Lateral malleolus	1	0.72
Astragalus	0	0.00
Calcaneus	0	0.00
Navicular cuboid	1	0.72
Cuniform pes	0	0.00
1st tarsal	0	0.00
2nd tarsal	0	0.00
Metatarsal	1	0.72
1st phalanx	3	2.16
2nd phalanx	1	0.72
3rd phalanx	1	0.72
Proximal sesamoid	0	0.00
Distal sesamoid	1	0.72
Uppertooth	1	0.72
Incisor/canine	3	2.16
Lower pre/molar	3	2.16
ELEMENT NISP	**139**	**100%**
FRAGMENTS		
Metapodial	12	3.02
Longbone fragment	244	61.31
Costal cart	0	0.00
Scapula cart	0	0.00
Skull fragment	5	1.26
Tooth fragment	6	1.51
Rib fragment	117	29.40
Vert fragment	12	3.02
pes/manus	0	0.00
Indeterminate	2	0.50
FRAGMENT NISP	**398**	**100%**
TOTAL COUNT	**537**	

Table 10. NISP, DkPj-1, 1985/85 excavation area (features included, bulk removed).

ELEMENTS	Level 1		Level 2		Level 3		Level 4		Levels 5 to 7		NI SP	
	#	%	#	%	#	%	#	%	#	%	#	%
Skull	42	2.06	62	2.33	22	2.10	11	3.04	0	0.00	137	2.19
Mandible	23	1.13	64	2.40	29	2.76	2	0.55	1	0.76	119	1.91
Hyoid	1	0.05	0	0.00	0	0.00	0	0.00	0	0.00	1	0.02
Atlas	1	0.05	5	0.19	1	0.10	0	0.00	0	0.00	7	0.11
Axis	1	0.05	1	0.04	1	0.10	0	0.00	2	1.52	5	0.08
Cervical vert	6	0.29	21	0.79	6	0.57	2	0.55	5	3.79	40	0.64
Thoracic vert	20	0.98	42	1.58	23	2.19	6	1.66	2	1.52	93	1.49
Lumbar vert	7	0.34	21	0.79	10	0.95	4	1.10	0	0.00	42	0.67
Sacrum	0	0.00	9	0.34	1	0.10	0	0.00	0	0.00	10	0.16
Caudal vert	1	0.05	4	0.15	3	0.29	1	0.28	0	0.00	9	0.14
Rib	40	1.96	126	4.73	58	5.53	16	4.42	2	1.52	242	3.88
Sternabra	0	0.00	0	0.00	0	0.00	1	0.28	0	0.00	1	0.02
Pelvis	46	2.26	58	2.18	25	2.38	7	1.93	4	3.03	140	2.24
Scapula	27	1.33	100	3.75	36	3.43	14	3.87	4	3.03	181	2.90
Humerus	63	3.09	111	4.17	44	4.19	9	2.49	9	6.82	236	3.78
Radius	143	7.02	168	6.31	49	4.67	11	3.04	6	4.55	377	6.04
Ulna	63	3.09	103	3.87	39	3.72	13	3.59	4	3.03	222	3.56
Scaphoid	45	2.21	47	1.76	19	1.81	12	3.31	2	1.52	125	2.00
Lunate	55	2.70	36	1.35	13	1.24	4	1.10	2	1.52	110	1.76
Cuneiform	45	2.21	45	1.69	15	1.43	6	1.66	0	0.00	111	1.78
Pisiform	14	0.69	8	0.30	5	0.48	0	0.00	0	0.00	27	0.43
Magnum	47	2.31	36	1.35	12	1.14	6	1.66	2	1.52	103	1.65
Unciform	46	2.26	38	1.43	9	0.86	4	1.10	2	1.52	99	1.59
5th Metacarpal	3	0.15	6	0.23	0	0.00	0	0.00	0	0.00	9	0.14
Metacarpal	81	3.98	107	4.02	36	3.43	8	2.21	2	1.52	234	3.75
Femur	36	1.77	64	2.40	45	4.29	15	4.14	7	5.30	167	2.67
Patella	25	1.23	31	1.16	13	1.24	10	2.76	0	0.00	79	1.27
Tibia	96	4.71	182	6.83	73	6.96	29	8.01	7	5.30	387	6.20
Lateral malleolus	26	1.28	34	1.28	17	1.62	8	2.21	0	0.00	85	1.36
Astragalus	91	4.47	96	3.60	37	3.53	21	5.80	25	18.94	270	4.32
Calcaneus	76	3.73	110	4.13	22	2.10	10	2.76	3	2.27	221	3.54
Navicular cuboid	69	3.39	60	2.25	22	2.10	8	2.21	3	2.27	162	2.59
Cuniform pes	41	2.01	54	2.03	25	2.38	10	2.76	2	1.52	132	2.11
1st tarsal	4	0.20	6	0.23	4	0.38	2	0.55	0	0.00	16	0.26
2nd tarsal	5	0.25	4	0.15	2	0.19	0	0.00	0	0.00	11	0.18
Metatarsal	74	3.63	100	3.75	45	4.29	8	2.21	4	3.03	231	3.70
1st phalanx	180	8.84	222	8.33	90	8.58	27	7.46	17	12.88	536	8.58
2nd phalanx	214	10.51	199	7.47	74	7.05	31	8.56	10	7.58	528	8.46
3rd phalanx	85	4.17	113	4.24	43	4.10	20	5.52	0	0.00	261	4.18
Proximal sesamoid	78	3.83	59	2.21	26	2.48	6	1.66	3	2.27	172	2.75
Distal sesamoid	36	1.77	37	1.39	11	1.05	8	2.21	1	0.76	93	1.49
Uppertooth	31	1.52	34	1.28	17	1.62	7	1.93	1	0.76	90	1.44
Incisor/canine	25	1.23	18	0.68	15	1.43	3	0.83	0	0.00	61	0.98
Lower pre/molar	25	1.23	23	0.86	12	1.14	2	0.55	0	0.00	62	0.99
ELEMENT NISP	**2037**	**100%**	**2664**	**100%**	**1049**	**100%**	**362**	**100%**	**132**	**100%**	**6244**	**100%**
FRAGMENTS												
Metapodial	129	50.59	126	33.33	57	30.81	11	17.19	5	25.00	328	36.36
Longbone fragment	55	21.57	106	28.04	55	29.73	17	26.56	11	55.00	244	27.05
Costal cart	3	1.18	0	0.00	0	0.00	0	0.00	1	5.00	4	0.44
Scapula cart	0	0.00	1	0.26	0	0.00	0	0.00	0	0.00	1	0.11
Skull fragment	5	1.96	22	5.82	11	5.95	6	9.38	1	5.00	45	4.99
Tooth fragment	11	4.31	20	5.29	4	2.16	4	6.25	0	0.00	39	4.32
Rib fragment	28	10.98	67	17.72	36	19.46	17	26.56	1	5.00	149	16.52
Vert fragment	22	8.63	32	8.47	19	10.27	5	7.81	1	5.00	79	8.76
pes/manus	0	0.00	1	0.26	0	0.00	0	0.00	0	0.00	1	0.11
Indeterminate	2	0.78	3	0.79	3	1.62	4	6.25	0	0.00	12	1.33
FRAGMENT NISP	**255**	**100%**	**378**	**100%**	**185**	**100%**	**64**	**100%**	**20**	**100%**	**902**	**100%**
TOTAL COUNT	**2292**		**3042**		**1234**		**426**		**152**		**7146**	

there were very few observed differences in the faunal remains from the two different seasons. This is shown graphically in Figure 37 where the NISP for a selection of 16 skeletal elements are plotted for the two different seasons.

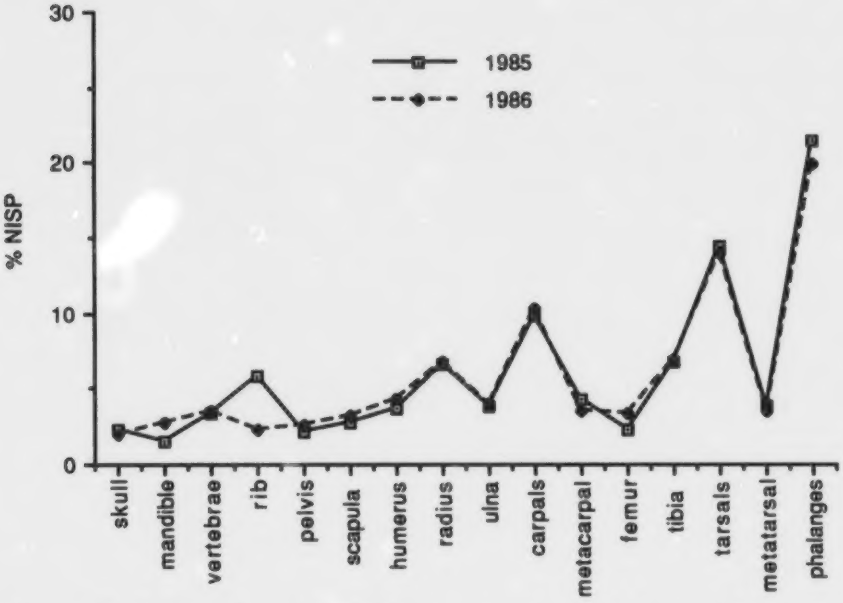


Figure 37. Comparison of NISP as percent of total assemblage for the 1985 and 1986 field seasons, DkPj-1.

The similarities between the results of the two seasons are even more striking when the limb bones alone are viewed (Figure 38). These bones composed the great bulk of the faunal remains for both seasons. The observed similarity in NISP lends some confidence to the assumption that the assemblages have been produced by similar combinations of natural and cultural activity and, hence, can be combined for the purposes of this study.

Comparison of Appendix 1 and Table 10 highlights some important aspects of the Head-Smashed-In faunal assemblage. The NISP counts of major elements alone convey an erroneous impression of skeletal representation. For example, Table 10 indicates that 137 items (2.2%) of the assemblage are skull, yet Appendix 1 reveals that fully 86 of these

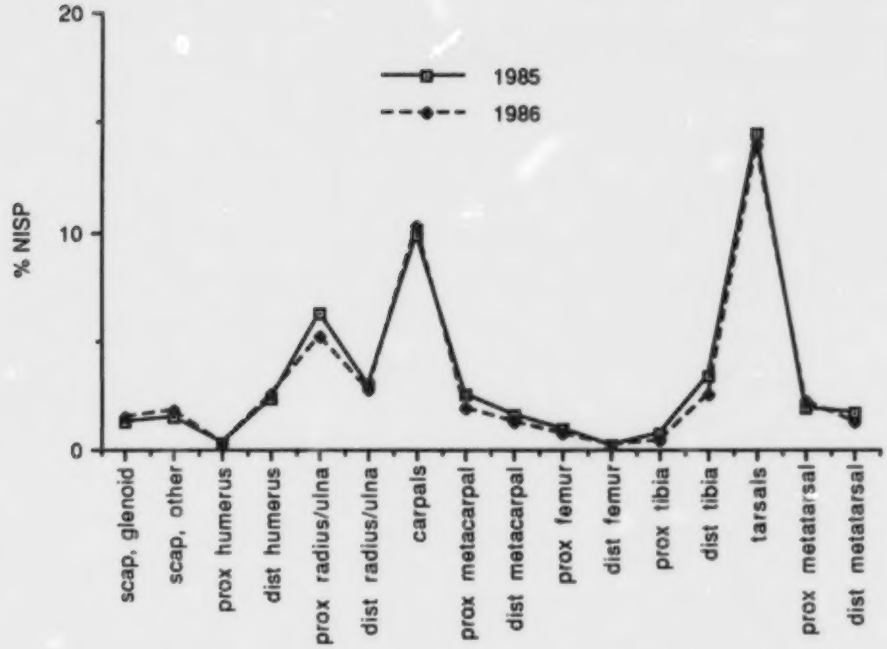


Figure 38. Comparison of limb bone elements from 1985 and 1986 excavations at Head-Smashed-In, % NISP.

entries (62.8%) consist of only the petrous bone. This bone portion, one of the hardest bones in the body, is consistently our most common skull element. No complete skulls were recovered. As it is unlikely that the petrous was removed from the skull at the kill site, its presence does indicate that complete skulls were occasionally transported down to the processing area.

Similar trends of differential preservation (arising from either cultural or natural reasons) are evident in many of the other elements. Table 10 shows 140 entries for the pelvis, but 103 (73.6%) of these consist of only the hard articular surface of the acetabulum. Over 75 percent of the rib elements are broken pieces of the rib body. Over 61 percent of all humeri are only distal ends, as are over 45 percent of all tibiae. This latter element has a noticeably high NISP count of shaft portions (n=159). This can be attributed to the distinctive nature of the tibia shaft. With a square shape and prominent bony ridges for muscle attachment, the identification of small shaft splinters from this bone is considerably easier than for many of the other limb bones. The same tends to be true for the femur shaft. Thus, NISP counts at a site like Head-Smashed-In are not simply a measure of the actual abundance of a certain element portion; they are heavily influenced by inherent properties of each bone which affect the degree of identifiability of the specimen. The category "Long bone Fragment" near the bottom of Appendix 1 and Table 10 accounts for many shaft portions of humeri, radii, metapodials and other elements lacking distinctive identification hallmarks.

From Appendix 1, it can be seen that complete major skeletal elements are almost non-existent in the Head-Smashed-In assemblage. If the smaller bones (carpals, tarsals, phalanges, patella, sesamoids and all classified "fragments") are omitted, this leaves a total of 3,094 bones, only 14 (0.45%) of which are complete. Most of these (n=8) are metacarpals. The metacarpal was also our most numerous complete bone of all the major elements from the 1984 excavations (n=3). The reasons for this apparent pattern are unclear, and the numbers involved are so low as to cast doubt on any attempt to make too much of it. The carpals, tarsals and similar small, hard bones commonly are found complete. In general, however, all of the major skeletal elements recovered from the Head-Smashed In processing area are in fragmented condition.

Very small amounts of axial material were recovered from the processing area excavations. Only 3.3% of the elements are vertebral, and only 13.5% are from any part of the axial skeleton. (In order to allow for a clear separation of the leg bones, which make up the bulk of the assemblage, the pelvis has been included with axial material throughout this report.) The best represented axial elements are ribs (3.9%) followed by pelves (2.2%), skull (2.2%) and mandible (1.9%). As seen in Appendix 1, vertebrae are scarce and are seldom complete (four complete specimens of a sample of 206). Most often, except for the thoracic, vertebrae are represented by the body or centrum. This seems to be the portion of the element that retains an identifiable shape even after severe taphonomic processes have affected the bone. In other words, a badly fragmented or weathered vertebrae centrum can often still be identified as being cervical, thoracic, and so on, while the fragments of the spinous processes generally cannot - hence, the high proportion of centrums. Most of those items classed as "vert fragment" in Appendix 1 are pieces of spinous processes which cannot be identified as to a specific element. Only the thoracic has a higher percentage of vertebral spines than bodies. This may be due to the fact that these spines tend to be more diagnostic of a specific vertebrae. Caudal vertebrae are very rare. As there is little reason to suspect these have been processed for food or that they are more prone to taphonomic destruction than other vertebrae, it seems more likely that they remained intact with the hides and were removed from the site. Frison (1973:51) also notes the absence of caudal vertebrae in the processing area at the Wardell site.

In general, it can be said that axial material is poorly represented in the processing area. This is consistent with previously reported models of Plains Indian bison butchering scenarios which attest to the practice of leaving many of these elements at the kill locations (see Frison 1970, 1973, 1978, Frison *et al.* 1978; Wheat 1972). However, in the case of Head-Smashed-In, it cannot be asserted confidently that the bias against axial material in the processing area is a direct reflection of intentional selection. Taphonomic reduction and elimination of this material are equally possible.

Turning to the elements of the appendicular portion of the skeleton recovered from the processing area, these account for fully 83.9 percent of all identified specimens, exclusive of long bone fragments. Again, this would be as predicted by our general models of Plains Indian butchering techniques which assert that leg bones would be preferentially selected to be transported from the kill to the processing area (see Frison 1970, 1973; Frison *et al.* 1978); however, the aspect of preservation again confounds these interpretations. Limb bones, as the main weight-bearing elements in bison, are typically harder, denser bones than are axial elements (see Lyman 1982, 1985). Thus, many of these, or at least certain portions of them, will be more prone to survival than axial elements. For example, the carpals, tarsals and phalanges are among the densest bones in the body of large ungulates (Lyman 1982). From Appendix 1, it can be seen that these bones, plus the sesamoids and the patella, make up 44.1% of all bison bones recovered from the Head-Smashed-In processing area. Furthermore, these same bones make up more that half (57.1%) of all appendicular elements. These bones are also the ones most commonly found in their complete form. Even taking into account the greater number of some these bones in the body (e.g., phalanges and sesamoids), they still emerge as the most common elements at the site.

Is this a function of preservation of the hardest, most durable specimens or a result of the intentional discard of bones known to be of little food or other value? Binford (1978, 1981) and Perkins and Daly (1968) have argued that these elements will often travel with the more desirable bones as "riders"; the effort to remove them is more work than to simply carry them along with other portions of the legs. Thus, one could argue that their strong representation in the assemblage is a function of transporting them from the kill to the processing area where, upon refined butchering, they are discarded more or less whole. Yet it is equally possible that the original composition of the assemblage did not favour these elements above all others but that attritional processes have selectively removed greater numbers of other, less dense elements.

The major limb bones make up over 30% of all fauna recovered from the block excavation area. By NISP, the major bones of the forelimb (scapula, humerus, radius, ulna and metacarpal) make up 20.0 percent of all recovered fauna. For the hind limb (femur, tibia and metatarsal), the figure is 12.6%, or 13.8% if the patella is included. As Appendix 1 reveals, however, there is a wide difference in the representation of the various portions of these elements. The most extreme cases are the humerus, with 146 specimens identified as distal ends and only 21 proximal ends, and the tibia, with 37 proximal ends and 175 distal ends. In contrast, the metapodials tend to have fairly similar representation of articular ends.

When the block excavation area is examined by levels (Table 10), it can be seen that there are few major differences between the fauna from each arbitrary 10 cm level. Numbers of specimens differ, in that level 2 was the richest bone layer (as it was for lithic remains and fire-broken rock) and in that the total number of all elements declines dramatically beginning in level 3. However, the percentage of the assemblage composed by each element changes little until levels 5-7 where the extremely low frequencies yield skewed figures. It may be noteworthy that, while the small, hard bones of the limbs (carpals, tarsals, etc.) dominate the percentage composition of the first level, from the second level onward, the importance of these tends to decline slightly in terms of percent of the level assemblage. Bones less well represented in the assemblage of the first level, such as vertebrae, ribs, scapula, pelvis and some of the major limb bones, tend to increase in relative percentage in the subsequent levels. Since there is no immediately apparent reason to suspect that a change in the use of the site or in butchering practices has occurred, these slight differences may reflect the enhanced preservation of less dense elements in the deeper levels. As the quality of preservation increases, albeit slightly, the relative importance of the especially durable items declines.

MNE and MAU Measures of Assemblage Composition

Appendix 2 presents the full record of MNE values for all skeletal elements, including the features, from the block excavation for both seasons. As mentioned above, the MNE values are restricted to those elements which are either a whole bone or a whole portion of a bone. The severe reduction between the NISP values (Table 10) and the MNE values of Appendix 2 are apparent. Including isolated teeth, the MNE for the assemblage is 2,521 specimens, or 40.4% of the NISP value. The greatest reduction in element frequency when comparing NISP and MNE is seen in the axial elements and the upper limb bones. The MNE for the skull is 39; nearly all (n=37) are petrous bones. (Thus, of 86 petrous bones recovered, 37 are complete specimens.) The mandible count drops from 119 to 7, thoracic vertebrae from 93 to 1, ribs from 242 to 12, pelves from 140 to 4, the humerus from 236 to 24 and the femur from 167 to 6. It is only with the lower limb bones, the radius, tibia, metacarpal and metatarsal, that the MNE values begin to approach the NISP values. For these elements, the MNE values are 27.9%, 24.3%, 43.2% and 44.6 percent, respectively, of the total NISP values. Table 11 gives a comparison of NISP and MNE values, as well as the % MNE.

The greatest correspondence between the NISP and the MNE counts is seen in the small, hard bones of the lower limbs. The % MNE for the carpals ranges from 62.2 to 88.9% with a mean of 71.7%. The tarsals range from 22.6 to 100% (one complete portion of a single hyoid bone accounts for the 100%) with a mean of 67.8%. The phalanges have a mean % MNE of 57.0%, and the sesamoids have a mean of 84.0 percent. As can be seen in Table 11, even when the MNE counts for these bones are converted to MAU values (by dividing the MNE by

Table 11. DkPj-1: 1985/86 excavations, block area, MNE, MAU and MAU ratio (features included, bulk removed).

ELEMENT	NISP	MNE	% MNE	MAU	RATIO MAU
Skull (petrous)	86	37	43.02	18.50	23.42
Skull (other)	51	2	3.92	1.00	1.27
Mandible	119	7	5.88	3.50	4.43
Hyoid	1	1	100.00	0.50	0.63
Atlas	7	1	14.29	1.00	1.27
Axis	5	1	20.00	1.00	1.27
Cervical	40	10	25.00	2.00	2.53
Thoracic	93	1	1.08	0.07	0.09
Lumbar	41	4	9.76	0.80	1.01
Sacrum	10	2	20.00	2.00	2.53
Caudal	9	2	22.22	0.11	0.14
Rib head	58	11	18.97	0.39	0.50
Rib body	183	1	0.55	0.04	0.05
Pelvis (acetabulum)	103	4	3.88	2.00	2.53
Pelvis (other)	36	0	0.00	0.00	0.00
Scapula (glenoid)	79	23	29.11	11.50	14.56
Scapula (other)	102	4	3.92	2.00	2.53
Proximal Humerus	21	1	4.76	0.50	0.63
Shaft Humerus	68	0	0.00	0.00	0.00
Distal Humerus	146	23	15.75	11.50	14.56
Proximal Radius	181	55	30.39	27.50	34.81
Shaft Radius	53	2	3.77	1.00	1.27
Distal Radius	137	48	35.04	24.00	30.38
Proximal Ulna	150	5	3.33	2.50	3.16
Shaft Ulna	49	1	2.04	0.50	0.63
Distal Ulna	17	0	0.00	0.00	0.00
Proximal Metacarpal	136	46	33.82	23.00	29.11
Shaft Metacarpal	7	0	0.00	0.00	0.00
Distal Metacarpal	81	47	58.02	23.50	29.75
Scaphoid	125	86	68.80	43.00	54.43
Lunate	110	72	65.45	36.00	45.57
Cuneiform	111	69	62.16	34.50	43.67
Pisiform	27	24	88.89	12.00	15.19
Magnum	115	85	73.91	42.50	53.80
Unciform	99	70	70.71	35.00	44.30
5th Metacarpal	9	7	77.78	3.50	4.43
Proximal Femur	55	5	9.09	2.50	3.16
Shaft Femur	93	1	1.08	0.50	0.63
Distal Femur	16	0	0.00	0.00	0.00
Patella	79	26	32.91	13.00	16.46
Proximal Tibia	37	2	5.41	1.00	1.27
Shaft Tibia	159	4	2.52	2.00	2.53
Distal Tibia	175	88	50.29	44.00	55.70
Lateral Malleolus	85	62	72.94	31.00	39.24
Astargalus	270	158	58.52	79.00	100.00
Calcaneus	221	50	22.62	25.00	31.65
Navicular Cuboid	162	97	59.88	48.50	61.39
Cuneiform Pes	132	105	79.55	52.50	66.46
1st Tarsal	16	13	81.25	6.50	8.23
2nd Tarsal	11	11	100.00	5.50	6.96
Proximal Metatarsal	127	43	33.86	21.50	27.22
Shaft Metatarsal	7	1	14.29	0.50	0.63
Distal Metatarsal	94	59	62.77	29.50	37.34
1st Phalanx	536	282	52.61	35.25	44.62
2nd Phalanx	528	309	58.52	38.63	48.89
3rd Phalanx	261	156	59.77	19.50	24.68
Proximal Sesamoid	172	139	80.81	8.69	11.00
Distal Sesamoid	93	81	87.10	10.13	12.82

the count of each bone in the living animal), they continue to be the dominant elements in the Head-Smashed-In assemblage. It is tempting to suggest that this dominance is a result of the enhanced preservation of these elements because of their hard, dense nature (see Lyman 1982). Yet, the generally low utility of these elements as a food source (Binford 1978), or as any other useful product, could also account for their relative abundance in the archaeological record. Ultimately, it may be a combination of the failure to process these bones for any food or tool use, the propensity to discard these elements at the site, and the greater density of the bones that account for the frequency of these elements.

In addition, Table 11 also gives the MAU ratio for all elements. This measure follows that of Todd (1987), whereby the element with the highest MAU value, in this case the astragalus, is assigned a value of 100 and all other elements are ranked according to this value. One of the subsurface pits excavated in 1985, feature 85-4, contained 42 astragali, nearly all of which were complete. Yet even without this unusual occurrence, the astragalus would have had the highest MAU count, followed closely by other carpals and tarsals. Of the larger skeletal elements, the distal tibia consistently outranks the other elements. The NISP, MNE and MAU for this element are all higher than the other major bones. The distal tibia is again one of the more dense bones in the body (see Lyman 1982 and discussion of bone density above). That the distal tibia articulates with our most numerous (MAU) element, the astragalus, may indicate the discard of these two elements as a unit.

The proximal and distal ends of the radii and of the metapodials are the next most common MAU categories. The least common MAU categories are all of the axial elements, aside from the petrous bone of the skull, and several articular ends of limb bones. Regarding the latter, the proximal humerus (MAU 0.50), the proximal and distal femur (MAU 2.50 and 0.00), and the proximal tibia (MAU 1.00) are noteworthy.

Another way of examining the representation of skeletal elements from the processing area is presented in Table 12. Based on the highest MAU value, 79 for the astragalus, the number of items expected for each bone category is calculated. Thus, with a minimum number of 79 astragali and two of these per animal, we would also expect a minimum of 79 for other elements which also occur twice in the skeleton, or a MAU value of

Table 12. Complete elements observed (MNE & MAU) and expected values, DkPj-1, 1985/86 fauna.

ELEMENT	MNE	MAU	EXPECTED	%
Astragalus	158	79.00	79.00	100.00
Cuneiform Pes	105	52.50	79.00	66.46
Navicular Cuboid	97	48.50	79.00	61.39
Distal Tibia	88	44.00	79.00	55.70
Scaphoid	86	43.00	79.00	54.43
Magnum	85	42.50	79.00	53.80
Lunate	72	36.00	79.00	45.57
Unciform	70	35.00	79.00	44.30
Cuneiform	69	34.50	79.00	43.67
Lateral Malleolus	62	31.00	79.00	39.24
Distal Metatarsal	59	29.50	79.00	37.34
Proximal Radius	55	27.50	79.00	34.81
Calcaneus	50	25.00	79.00	31.65
Distal Radius	48	24.00	79.00	30.38
Distal Metacarpal	47	23.50	79.00	29.75
Proximal Metacarpal	46	23.00	79.00	29.11
Proximal Metatarsal	43	21.50	79.00	27.22
Skull (petrous)	37	18.50	79.00	23.42
Patella	26	13.00	79.00	16.46
Pisiform	24	12.00	79.00	15.19
Scapula (glenoid)	23	11.50	79.00	14.56
Distal Humerus	23	11.50	79.00	14.56
2nd Phalanx	309	38.63	316.00	12.22
1st Phalanx	282	35.25	316.00	11.16
1st Tarsal	13	6.50	79.00	8.23
2nd Tarsal	11	5.50	79.00	6.96
3rd Phalanx	156	19.50	316.00	6.17
Sacrum	2	2.00	39.50	5.06
Mandible	7	3.50	79.00	4.43
5th Metacarpal	7	3.50	79.00	4.43
Distal Sesamoid	81	10.13	316.00	3.20
Proximal Ulna	5	2.50	79.00	3.16
Proximal Femur	5	2.50	79.00	3.16
Pelvis (acetabulum)	4	2.00	79.00	2.53
Scapula (other)	4	2.00	79.00	2.53
Atlas	1	1.00	39.50	2.53
Axis	1	1.00	39.50	2.53
Proximal Sesamoid	139	8.69	632.00	1.37
Skull (other)	2	1.00	79.00	1.27
Proximal Tibia	2	1.00	79.00	1.27
Cervical	10	2.00	197.50	1.01
Hyoid	1	0.50	79.00	0.63
Proximal Humerus	1	0.50	79.00	0.63
Lumbar	4	0.80	197.50	0.41
Rib head	11	0.39	1106.00	0.04
Caudal	2	0.11	711.00	0.02
Thoracic	1	0.07	553.00	0.01
Rib body	1	0.04	1106.00	0.00
Pelvis (other)	0	0.00	79.00	0.00
Distal Ulna	0	0.00	79.00	0.00
Distal Femur	0	0.00	79.00	0.00

Expected values are based on MAU of 79 for the astragalus

39.5 for elements which occur only once, a MAU of 316 for elements which occur eight times in the body (four times as often as the astragalus), and so on. As seen in Table 12, nearly all of the elements which rank highest in percent of expected frequency are carpals and tarsals. The distal tibia and proximal radius are the highest ranking limb elements. Although numerically the most common bones of the entire assemblage, phalanges range from only about 6 to 12% of expected frequency based on the presence of 79 astragali. Axial elements and a few upper limb bone portions (i.e., distal femur and proximal humerus) are lowest in terms of expected frequency. Theoretically, one might suggest that the former is due to deliberate discard at the kill and the latter to intensive processing at the prairie level camp; however, these suggestions must be tempered by our knowledge of the generally poor preservation at the HSI processing area.

Features

Faunal material recovered from the features of the block excavation area are dealt with on an individual feature basis in the chapter on features. Here, the feature fauna will be examined as a whole, looking for patterns in the feature material and comparing this material to that from the surrounding excavations. This section considers primarily the faunal material from the two major subsurface pits, 85-4 and 85-5. Together, these two pits account for over 98% of all the fauna recovered from the 1985/86 features.

Features, as the remains of discrete bison processing episodes, can be presumed to have contained a different assemblage of faunal material than the general scatter of the prairie. Bones placed in a pit feature, for making soups or stews or for grease rendering, would not likely be a representative sample of all the available bones. Bones with specific qualities or associated with specific muscle and fat depots attached to the bones would be selected preferentially for processing which involved a subsurface pit. Investigating this possibility assumes that the fauna recovered from the two pit features actually played a role in the operation of the feature. It may be that the pits were cleaned out, reused, and perhaps finally abandoned with an assemblage of bone which bears little relevance to the function of the pit. This will be addressed below.

The NISP count and percent for the 591 elements recovered from the features is presented in Table 13. For comparison, Table 13 also shows the faunal assemblage from the block excavation with the feature totals removed. By and large, the two assemblages show few significant differences. The % NISP for most elements are very close. The astragalus is an exception, accounting for over 10% of all the bones from the features. As mentioned, feature pit 85-4 alone contained 42 astragali. In our experience at HSI, this is a highly anomalous situation and is discussed further in the features chapter. Other than this anomaly, the representation of carpals and tarsals is nearly equal to that seen in the block area. Phalanges, on the other hand, are more common in the features, accounting for over 33% of the assemblage. The same bones from the surrounding excavation area make up just over 20% of the sample. Other than these differences, the two assemblages are very similar (see Figure 39).

Thus, the features do not show the expected differences when compared to the fauna from the general processing area. Instead, the features simply duplicate the faunal record from the prairie. There are a number of possible explanations for this. First, it must be considered that there is truly little difference between the total sample of bones transported from the kill to the processing area and the elements which make their way into the processing features; that is, nearly all elements retrieved from the kill may have had a role in cooking or boiling activities. Second, it is possible that the features encountered in 1985/86 were reused on several occasions, and, with cleaning out and reuse, the faunal records of the processing area are essentially homogenized with that of the features. A third possibility is that taphonomic processes have worked similarly to homogenize the two samples. As discussed above, much of the faunal record from the prairie can be interpreted as differential preservation of the most durable elements of the skeleton. Given that the feature assemblage consists of mostly the same elements, the same explanation could apply. This could be true in spite of the fact that the faunal material from the features is in demonstrably better condition than that from the processing area.

Table 13. NISP, DkPj-1, 1985/86 excavations, features versus block area.

	1985/86 Features		1985/86 Block Excavation	
ELEMENT	NISP #	NISP %	NISP #	NISP %
Skull	19	3.46	118	2.07
Mandible	5	0.91	114	2.00
Hyoid	0	0.00	1	0.02
Atlas	1	0.18	6	0.11
Axis	2	0.36	3	0.05
Cervical vert	10	1.82	30	0.53
Thoracic vert	3	0.55	90	1.58
Lumbar vert	1	0.18	41	0.72
Sacrum	0	0.00	10	0.18
Caudal vert	0	0.00	9	0.16
Rib	5	0.91	237	4.16
Sternabra	0	0.00	1	0.02
Pelvis	8	1.46	132	2.32
Scapula	17	3.10	164	2.88
Humerus	20	3.64	216	3.79
Radius	13	2.37	364	6.39
Ulna	8	1.46	214	3.76
Scaphoid	9	1.64	116	2.04
Lunate	8	1.46	102	1.79
Cuneiform	9	1.64	102	1.79
Pisiform	4	0.73	23	0.40
Magnum	7	1.28	96	1.69
Unciform	7	1.28	92	1.62
5th Metacarpal	0	0.00	9	0.16
Metacarpal	15	2.73	219	3.85
Femur	15	2.73	152	2.67
Patella	2	0.36	77	1.35
Tibia	13	2.37	374	6.57
Lateral malleolus	1	0.18	84	1.47
Astragalus	55	10.02	215	3.78
Calcaneus	22	4.01	199	3.49
Navicular cuboid	19	3.46	143	2.51
Cuniform pes	14	2.55	118	2.07
1st tarsal	3	0.55	13	0.23
2nd tarsal	0	0.00	11	0.19
Metatarsal	25	4.55	206	3.62
1st phalanx	80	14.57	456	8.01
2nd phalanx	67	12.20	461	8.09
3rd phalanx	35	6.38	226	3.97
Proximal sesamoid	9	1.64	163	2.86
Distal sesamoid	3	0.55	90	1.58
Uppertooth	8	1.46	82	1.44
Incisor/canine	0	0.00	61	1.07
Lower pre/molar	7	1.28	55	0.97
ELEMENT NISP	**549**	**100%**	**5695**	**100%**
FRAGMENTS				
Metapodial	26	61.90	302	35.12
Longbone fragment	2	4.76	242	28.14
Costal cart	2	4.76	2	0.23
Scapula cart	0	0.00	1	0.12
Skull fragment	4	9.52	41	4.77
Tooth fragment	0	0.00	39	4.53
Rib fragment	1	2.38	148	17.21
Vert fragment	7	16.67	72	8.37
pes/manus	0	0.00	1	0.12
Indeterminate	0	0.00	12	1.40
FRAGMENT NISP	**42**	**100%**	**860**	**100%**
TOTAL COUNT	**591**		**6555**	

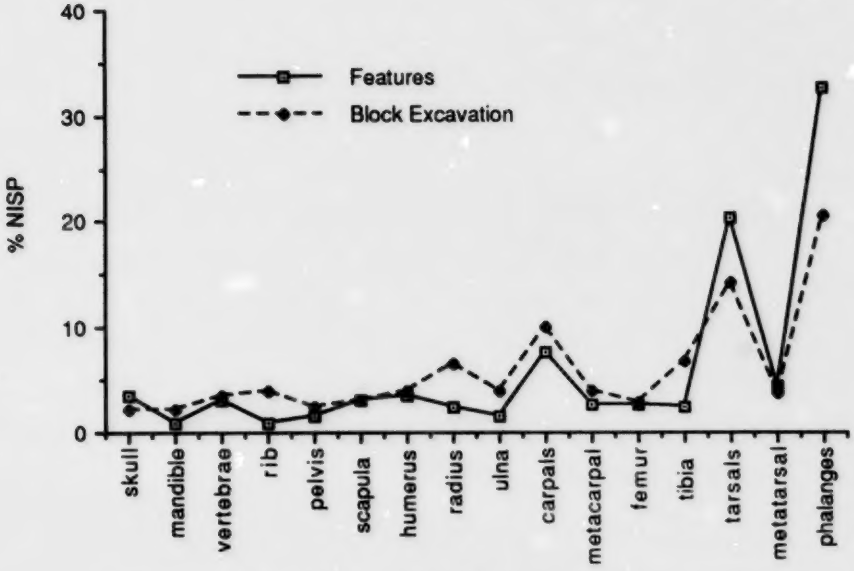


Figure 39. Comparison of % NISP, features and block excavation fauna from DkPj-1.

The Stratified Area

Eleven square metres of the block excavation area were situated over a small depositional basin which contained dark Ah horizon soil and artifacts extending to a depth of 45-50 cm below surface. This subdivision of the larger block excavation area has been termed the stratified block. As mentioned previously, a thin zone of nearly sterile, sandy soil separated the upper and lower portions of this horizon into nearly equal units, each about 25 cm thick (see Figure 7). This is the only evidence of stratification we have found in the processing area in the past four seasons at Head-Smashed-In, and it warrants a separate examination of the fauna from this area.

Unfortunately, during excavation the change in soil texture was minor and was not recognized until the wall profiles reached a depth of about 40 cm. Thus, our arbitrary 10 cm excavation levels cross-cut this sandy horizon. Specifically, the horizon falls in about the middle to lower part of level 3. The bottom of level 3 is essentially the bottom of the sandy horizon. All of levels 1 and 2 fall within the upper stratum, and all of levels 4, 5, 6 and 7 fall within the lower stratum. Level 3 contains the lowest part of the upper stratum, as well as the sandy horizon, but none of the lower stratum.

For this reason, level 3 has been combined with levels 1 and 2 to form the upper stratum. We have reported above the dating of this deposit, which indicates that the stratum above the sand layer was deposited after about 800 years B.P., and the lower stratum before about 1,300 years B.P. Diagnostic lithic artifacts suggest that levels 1 and 2 correspond to the Old Women's period, while 3 and 4 belong to the Avonlea period.

Table 14 presents the NISP faunal record, by levels, for the stratified area. Table 15 combines the levels into the groupings referred to as the upper and lower strata. Because features cross-cut the strata, possibly obscuring any patterns in the character of the faunal samples, they have been removed from these two tables. The first point to note is the numerical dominance of the upper stratum fauna. Over 90% of all bones were recovered from levels 1-3. This same distributional trend is true of the lithic artifacts and the fire-broken rock; thus, the fauna are not anomalous in this regard. This is unfortunate in that the small sample from the lower stratum is far less than desirable for comparison. Nevertheless, it is worth searching the data for patterns which may indicate change - or lack thereof - in bison butchering and utilization through time.

Overall, the record of fauna by levels within the stratified area, Table 14, does not differ significantly from the level record for the entire excavation area seen in Table 10. The small, hard bones - carpals, tarsals and phalanges - again make up about 45% of the stratified assemblage. Axial material is again very scarce. Limb bones are represented primarily by the hard articular ends and by fragments of shafts.

Before comparing the two stratigraphic levels, it is appropriate to examine each stratum for internal consistency in faunal representation. Figure 40 plots the % NISP of selected major skeletal elements for each of the first three levels, and Figure 41 does the same for the lower levels.

From Figure 40, it can be seen that, by and large, the three upper levels contain very similar faunal assemblages. As has already been noted, it is conspicuous that the % NISP for some of the more fragile elements - mandible, vertebrae, rib and scapula - is lowest in level 1. All of these elements increase slightly in importance in levels 2 and 3. Carpals, tarsals

Table 14. NISP, stratified area of block excavation, DkPj-1, 1985 and 1986 (features and bulk removed).

	Level 1		Level 2		Level 3		Level 4		Levels 5 to 7		N I S P	
ELEMENT	#	%	#	%	#	%	#	%	#	%	#	%
Skull	15	1.48	29	2.14	13	2.13	7	2.79	0	0.00	64	1.95
Mandible	11	1.09	41	3.03	23	3.76	2	0.80	0	0.00	77	2.35
Hyoid	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Atlas	0	0.00	1	0.07	0	0.00	0	0.00	0	0.00	1	0.03
Axis	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Cervical vert	1	0.10	14	1.03	2	0.33	0	0.00	1	2.13	18	0.55
Thoracic vert	7	0.69	27	1.99	17	2.78	6	2.39	2	4.26	59	1.80
Lumbar vert	5	0.49	11	0.81	5	0.82	2	0.80	0	0.00	23	0.70
Sacrum	0	0.00	2	0.15	0	0.00	0	0.00	0	0.00	2	0.06
Caudal vert	1	0.10	4	0.30	3	0.49	1	0.40	0	0.00	9	0.27
Rib	11	1.09	45	3.32	23	3.76	12	4.78	1	2.13	92	2.81
Sternabra	0	0.00	0	0.00	0	0.00	1	0.40	0	0.00	1	0.03
Pelvis	35	3.46	34	2.51	15	2.45	5	1.99	0	0.00	89	2.72
Scapula	15	1.48	58	4.28	20	3.27	9	3.59	0	0.00	102	3.11
Humerus	36	3.55	60	4.43	23	3.76	4	1.59	3	6.38	126	3.85
Radius	77	7.60	94	6.94	25	4.09	7	2.79	4	8.51	207	6.32
Ulna	41	4.05	54	3.99	21	3.44	11	4.38	3	6.38	130	3.97
Scaphoid	23	2.27	25	1.85	13	2.13	8	3.19	2	4.26	71	2.17
Lunate	26	2.57	22	1.62	6	0.98	2	0.80	2	4.26	58	1.77
Cuneiform	17	1.68	21	1.55	9	1.47	5	1.99	0	0.00	52	1.59
Pisiform	8	0.79	4	0.30	2	0.33	0	0.00	0	0.00	14	0.43
Magnum	25	2.47	15	1.11	8	1.31	5	1.99	2	4.26	55	1.68
Unciform	17	1.68	24	1.77	5	0.82	3	1.20	2	4.26	51	1.56
5th Metacarpal	2	0.20	3	0.22	0	0.00	0	0.00	0	0.00	5	0.15
Metacarpal	37	3.65	50	3.69	23	3.76	5	1.99	2	4.26	117	3.57
Femur	17	1.68	38	2.81	30	4.91	14	5.58	1	2.13	100	3.05
Patella	15	1.48	19	1.40	11	1.80	7	2.79	0	0.00	52	1.59
Tibia	49	4.84	91	6.72	43	7.04	24	9.56	3	6.38	210	6.41
Lateral malleolus	13	1.28	13	0.96	10	1.64	8	3.19	0	0.00	44	1.34
Astragalus	45	4.44	36	2.66	23	3.76	10	3.98	2	4.26	116	3.54
Calcaneus	43	4.24	53	3.91	15	2.45	6	2.39	1	2.13	118	3.60
Navicular cuboid	35	3.46	30	2.22	10	1.64	4	1.59	2	4.26	81	2.47
Cuniform pes	17	1.68	28	2.07	15	2.45	9	3.59	0	0.00	69	2.11
1st tarsal	3	0.30	3	0.22	4	0.65	2	0.80	0	0.00	12	0.37
2nd tarsal	2	0.20	3	0.22	2	0.33	0	0.00	0	0.00	7	0.21
Metatarsal	31	3.06	53	3.91	26	4.26	6	2.39	1	2.13	117	3.57
1st phalanx	76	7.50	117	8.64	53	8.67	15	5.98	6	12.77	267	8.15
2nd phalanx	87	8.59	97	7.16	39	6.38	19	7.57	2	4.26	244	7.45
3rd phalanx	40	3.95	52	3.84	25	4.09	16	6.37	0	0.00	133	4.06
Proximal sesmoid	56	5.53	32	2.36	13	2.13	2	0.80	3	6.38	106	3.24
Distal sesmoid	28	2.76	22	1.62	9	1.47	5	1.99	1	2.13	65	1.98
Upper tooth	15	1.48	9	0.66	9	1.47	5	1.99	1	2.13	39	1.19
Incisor/canine	20	1.97	9	0.66	10	1.64	2	0.80	0	0.00	41	1.25
Lower pre/molar	11	1.09	11	0.81	8	1.31	2	0.80	0	0.00	32	0.98
ELEMENT NISP	1013	100%	1354	100%	611	100%	251	100%	47	100%	3276	100%
FRAGMENTS												
Metapodial	64	47.41	66	30.28	32	29.09	8	15.69	3	21.43	173	32.77
Longbone fragment	23	17.04	45	20.64	26	23.64	11	21.57	10	71.43	115	21.78
Costal cart	0	0.00	0	0.00	0	0.00	0	0.00	1	7.14	1	0.19
Scapula cart	0	0.00	1	0.46	0	0.00	0	0.00	0	0.00	1	0.19
Skull fragment	2	1.48	8	3.67	6	5.45	4	7.84	0	0.00	20	3.79
Tooth fragment	10	7.41	19	8.72	4	3.64	4	7.84	0	0.00	37	7.01
Rib fragment	25	18.52	59	27.06	25	22.73	16	31.37	0	0.00	125	23.67
Vert fragment	6	4.44	16	7.34	14	12.73	4	7.84	0	0.00	40	7.58
pes/manus	2	1.48	1	0.46	0	0.00	0	0.00	0	0.00	3	0.57
Indeterminate	3	2.22	3	1.38	3	2.73	4	7.84	0	0.00	13	2.46
FRAGMENT NISP	135	100%	218	100%	110	100%	51	100%	14	100%	528	100%
TOTAL COUNT	1148		1572		721		302		61		3804	

Table 15. NISP, stratified area of block excavation, DkPj-1, 1985 and 1986 (features and bulk removed).

	Upper Stratum	Levels 1,2,3	Lower Stratum	Levels 4,5,6
ELEMENT	#	%	#	%
Skull	57	1.91	7	2.35
Mandible	75	2.52	2	0.67
Hyoid	0	0.00	0	0.00
Atlas	1	0.03	0	0.00
Axis	0	0.00	0	0.00
Cervical vert	17	0.57	1	0.34
Thoracic vert	51	1.71	8	2.68
Lumbar vert	21	0.71	2	0.67
Sacrum	2	0.07	0	0.00
Caudal vert	8	0.27	1	0.34
Rib	79	2.65	13	4.36
Sternabra	0	0.00	1	0.34
Pelvis	84	2.82	5	1.68
Scapula	93	3.12	9	3.02
Humerus	119	4.00	7	2.35
Radius	196	6.58	11	3.69
Ulna	116	3.90	14	4.70
Scaphoid	61	2.05	10	3.36
Lunate	54	1.81	4	1.34
Cuneiform	47	1.58	5	1.68
Pisiform	14	0.47	0	0.00
Magnum	48	1.61	7	2.35
Unciform	46	1.54	5	1.68
5th Metacarpal	5	0.17	0	0.00
Metacarpal	110	3.69	7	2.35
Femur	85	2.85	15	5.03
Patella	45	1.51	7	2.35
Tibia	183	6.15	27	9.06
Lateral malleolus	36	1.21	8	2.68
Astragalus	104	3.49	12	4.03
Calcaneus	111	3.73	7	2.35
Navicular cuboid	75	2.52	6	2.01
Cuniform pes	60	2.01	9	3.02
1st tarsal	10	0.34	2	0.67
2nd tarsal	7	0.24	0	0.00
Metatarsal	110	3.69	7	2.35
1st phalanx	246	8.26	21	7.05
2nd phalanx	223	7.49	21	7.05
3rd phalanx	117	3.93	16	5.37
Proximal sesamoid	101	3.39	5	1.68
Distal sesamoid	59	1.98	6	2.01
Upper tooth	33	1.11	6	2.01
Incisor/canine	39	1.31	2	0.67
Lower pre/molar	30	1.01	2	0.67
ELEMENTS NISP	**2978**	**100%**	**298**	**100%**
FRAGMENTS				
Metapodial	162	34.99	11	16.92
Longbone fragment	94	20.30	21	32.31
Costal cart.	0	0.00	1	1.54
Scapular cart.	1	0.22	0	0.00
Skull fragment	16	3.46	4	6.15
Tooth fragment	33	7.13	4	6.15
Rib fragment	109	23.54	16	24.62
Vert fragment	36	7.78	4	6.15
Pes/manus	3	0.65	0	0.00
Indeterminate	9	1.94	4	6.15
FRAGMENT NISP	**463**	**100%**	**65**	**100%**
TOTAL COUNT	**3441**		**363**	

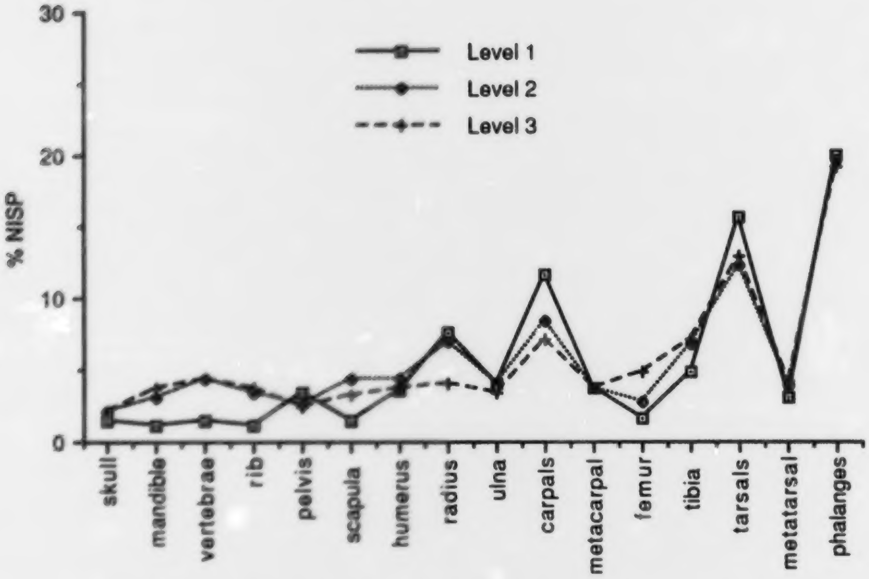


Figure 40. Comparison of % NISP for the upper three levels of the stratified area of the 1985/86 excavations, DkPj-1.

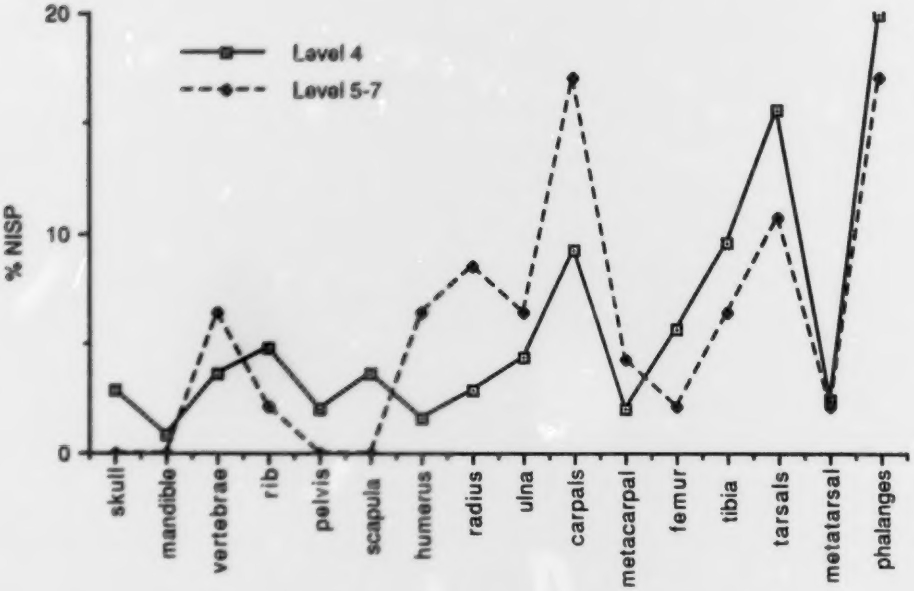


Figure 41. Comparison of % NISP for the lower levels of the stratified area of the 1985/86 excavations, DkPj-1.

and phalanges, on the other hand, form a larger percentage of level 1 than in the other two levels. It has been suggested that the enhanced preservation of the lower levels aids in preserving the more delicate elements, while the upper level is characterized by a greater percentage of the durable items. Otherwise, there are no significant differences between the upper three levels.

In Figure 41, greater differences are apparent between the fauna of the lower levels. However, the sample size for levels 5-7 is so small (1.3% of the entire assemblage) that the difference of a few bones in each element category can cause wide variation in the percent figures. Little can be said of these two levels; it is more productive to combine them and to consider the lower stratum as a whole.

Figure 42 plots the relative percent of select skeletal elements for the upper and lower strata. Keeping in mind the relatively small sample size of the lower stratum, in general there is no great difference between the two assemblages. The upper stratum shows a consistent percent of all axial elements, while the lower unit exhibits more variation. Limb bone values are mostly similar, although it is interesting to note that carpals, tarsals and phalanges all form a slightly higher percent of the lower stratum fauna. We would have expected these durable elements to be relatively more important in the upper levels. Greater detail of the differences between the two assemblages is provided in Figures 43 and 44 which plot the % NISP of limb bones and axial elements, respectively.

The appendicular assemblages are quite similar. Other than the noted slight increase in the relative percent of carpals and tarsals in the lower stratum there are almost no differences between the two data sets. Somewhat greater variability is seen in the % NISP of the axial elements. The upper unit has somewhat higher percent mandible and pelvis NISP, while the lower stratum, is has a greater percent of skull, thoracic vertebrae and ribs. No immediate explanation for this variability comes to mind, and the relative differences in percent are small enough that it is probably unwise to attempt to make too much of the observations. Again, the small sample size of the lower stratum may account for some or most of the noted variability.

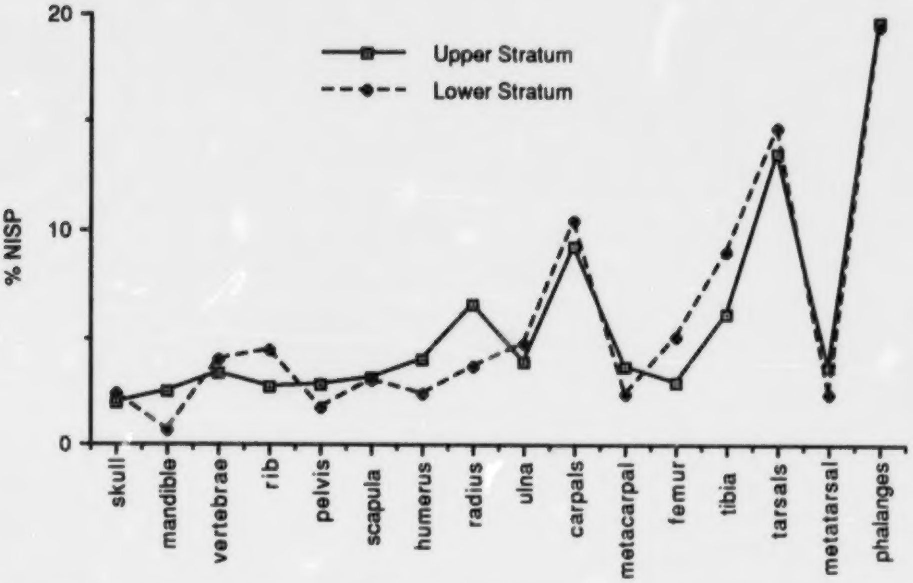


Figure 42. Comparison of % NISP for general skeletal elements from the stratified area of the 1985/86 excavation, DkPj-1.

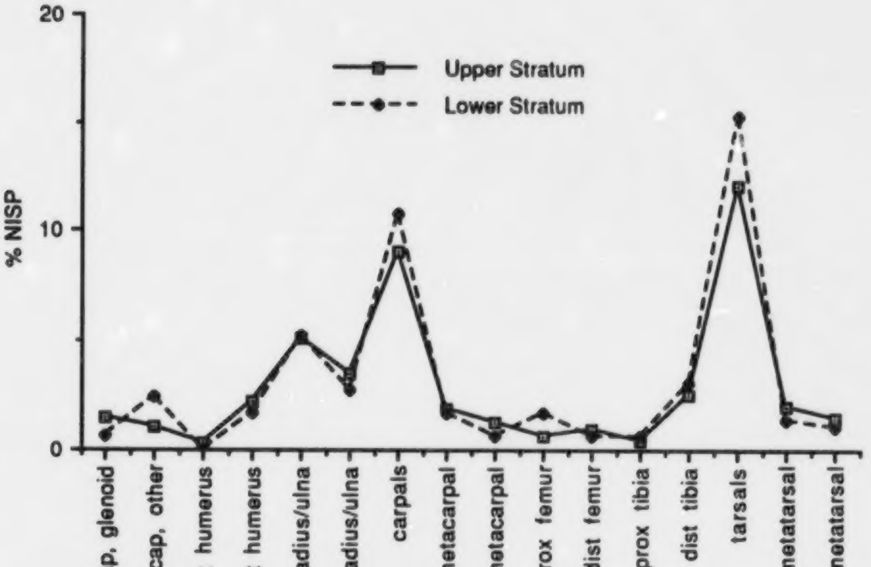


Figure 43. Comparison of % NISP for limb bone elements from the stratified area of the 1985/86 excavation, DkPj-1.

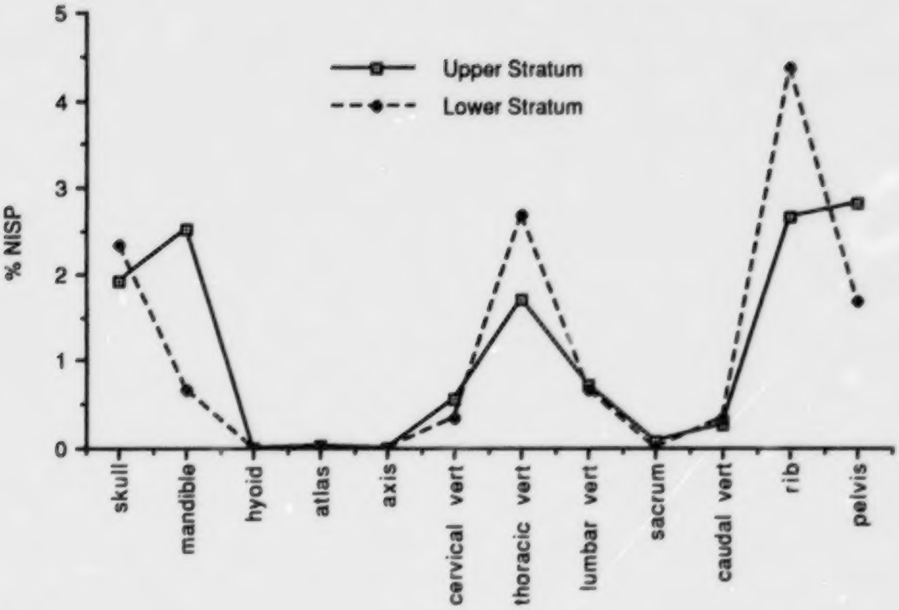


Figure 44. Comparison of % NISP for axial elements from the stratified area of the 1985/86 excavations, DkPj-1.

In general, it can be tentatively concluded there is little reason to believe that the faunal assemblages from the upper and lower strata are noticeably different. All NISP evidence suggests that the assemblages are relatively homogeneous. This further suggests that the two faunal samples likely were formed by similar processes. The question at hand is whether this process was one of human modification, natural deterioration or a combination of both. The taphonomic review presented above concluded that poorly preserved faunal assemblages, such as that at Head-Smashed-In, present great difficulties in assigning a causal agent to the observed patterns. The direct evidence of the various faunal modifiers, such as carnivore marks or the demonstrable absence of them, are lacking, and in a severely eroded faunal collection, negative evidence is of little value in supporting or refuting alternative hypotheses. Do the data from the two strata indicate that there has been little or no change in bison butchering and processing throughout most of the Late Prehistoric Period at Head-Smashed-In? Or do they indicate that taphonomic processes have operated consistently throughout this time period to homogenize faunal remains into one fairly uniform pattern? If the latter is the case, we are no further ahead in knowing if the two assemblages once differed, for the taphonomic reduction processes could have operated on two fundamentally different or two essentially identical assemblages and produced the homogenized residue evident today.

In the next chapter, a case is made that the upper two levels of the stratified area are equivalent in time to the use of the site by the makers of the Old Women's points, while levels 3 and 4 contain diagnostic materials attributable to makers of Avonlea points. If two different cultural groups did indeed occupy the site during the deposition of these arbitrary levels, then it may be appropriate to search for differences in faunal representation between these divisions of the strata rather than in the zones above and below the sterile sand layer. Accordingly, Figure 45 plots the relative percent of elements from the upper four levels. In this figure, the faunal remains from levels 1 and 2 have been combined into a single assemblage, as has the fauna from levels 3 and 4.

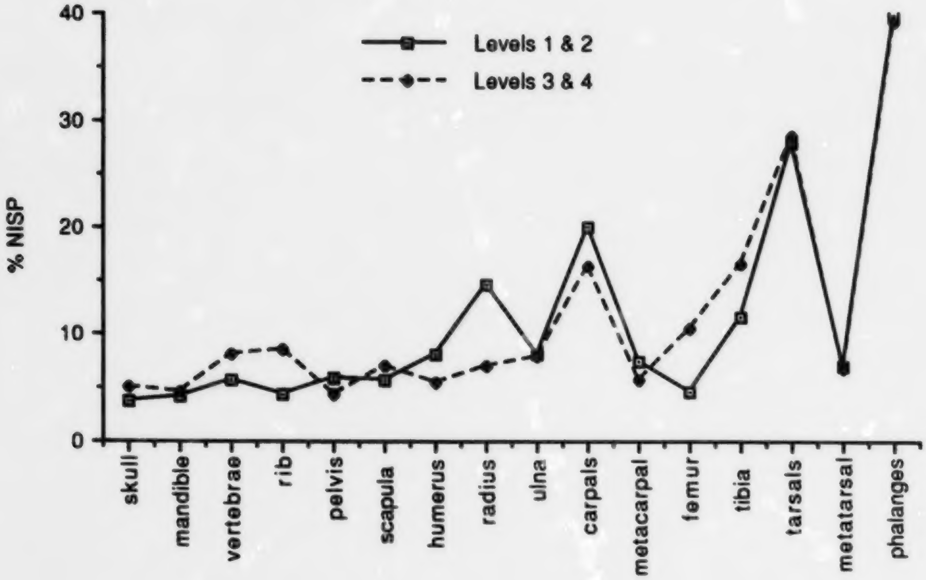


Figure 45. Comparison of % NISP from levels 1 & 2 and 3 & 4, from the stratified area, DkPj-1.

In general, the faunal assemblages from the two groupings of levels are quite similar. Rib and vertebral elements are slightly better represented in the lower levels. The main bones of the front limb, the humerus and radius, are somewhat more common in the upper levels. In contrast, the femur and tibia are somewhat more prevalent in the lower levels. Metapodials, tarsals and phalanges are essentially equal in representation, and the carpals are very close in % NISP. Again, it seems fair to conclude that there is little evidence of significant change through time in the faunal record of the HSI processing area.

The question of change over time in the use of Head-Smashed-In remains at the crux of faunal studies at the site. The 1985/86 excavations produced the only stratified remains encountered at the processing area, with materials recovered from buried contexts extending to a depth of 50 cm. It has been noted above that a number of measures, such as the weight of individual bones, indicate that the lower levels of the site contain bone that is somewhat better preserved than the upper level fauna. This being the case, it is tempting to suggest that the similarities in the assemblages from the two strata are a real reflection of consistent methods of butchering and processing throughout the Late Prehistoric Period. It should be obvious that this is an extremely tenuous conclusion for which the only real supporting data are poorly preserved bones, which all look pretty much the same.

Analysis Of Economic Utility

While no assemblage is without interpretive potential, the fragmentary and poorly preserved nature of the faunal material recovered from the 1985/86 excavations at the HSI processing area preclude a number of lines of archaeological analysis common in contemporary bison kill site reports. Axial material from the block excavation is exceedingly rare, and little can be done with this sample. The assemblage is dominated by the small, hard bones of the lower limbs which generally receive little attention by other researches. As a result, there are virtually no analytical models that can be employed to elucidate information which may reside in these materials. Leg bones of large mammals have received considerable attention in archaeological research, and, because they are fairly well represented at HSI, albeit in fragmentary form, attention will focus on these elements.

In the past decade, a method frequently employed in attempting to interpret prehistoric butchering and processing decisions and patterns is that of an assessment of the utility, or economic value, of certain parts of animal carcasses as developed by Binford (1978). To date, this approach has been employed in the Canadian Arctic (Morrison 1988; Will 1985) in the American Great Basin (Thomas and Mayer 1983), and in the North American Plains (Todd 1987; Speth 1983). Virtually all researchers have noted the potential danger in borrowing Binford's models, devised for Arctic conditions and based on the anatomy of a small sample of sheep and caribou, yet the method remains attractive. Binford's methods have been recently critiqued by Lyman (1984, 1985) and Metcalfe and Jones (1988), and Binford's marrow index specifically has been reviewed by Jones and Metcalfe (1988). The important concerns raised by these authors will be discussed in the following analysis.

Quantitative details of the limb bone assemblage recovered from the block excavation at HSI already have been presented. The following exercise will examine these data in light of Binford's proposed indices of the economic utility of large mammal carcass segments. Specifically, attention will focus on a comparison of our data with Binford's Modified General Utility Index (MGUI), with his Grease Index (GI), and with his Marrow Index (MI). Earlier in this chapter, we alluded to some new data on bison anatomy. These data will now be presented and will also used to examine the HSI faunal assemblage.

Table 16 presents the results of the study of the amount of grease, or fatty acids, in the leg bones of three bison. The sample included a 5 year old male killed in November (no. 4), a 3-4 year old male killed in April (no. 85-4-4) and a 3.5 year old female killed in December (84-11-1). The bison are all classified as plains bison (*B. b. bison*). Specimen 85-4-4 was obtained from the abattoir; the other two were from Elk Island National Park. The fresh bones were cleaned of all muscle, fat and tendon; the articular ends (at the ends of the marrow cavities) were sawed off. This technique was performed on a number of discard abattoir specimens to clarify the appropriate place to separate the end of the marrow cavities from the articular ends. Using a hydraulic press at the Department of Engineering, University of Alberta, the articular ends and the mid shafts of the three sets of leg bones were crushed to as fine a size as possible. The resulting bone chips and greasy

Table 16. Analysis of leg bones, modern *Bison bison*.

		Bison No. 4			Bison No. 84-11-1			Bison No. 85-4		
		% Water	% Dry	% Fat	% Water	% Dry	% Fat	% Water	% Dry	% Fat
prox humerus	a	15.7	51.9	32.4	12.4	48.4	39.2	16.5	51.5	32
	b			38.4			44.8			38.3
	c			34.4-42.4			44.1-45.4			36.5-40.1
humerus shaft	a	8.5	88.3	3.2	5.1	88.7	6.2	5.7	93.5	0.8
	b			3.5			6.5			0.9
	c			2.9-4.0			4.4-8.6			0.6-1.2
dist humerus	a	12.8	72.6	14.6	11.3	67.1	21.6	16.4	62.8	20.8
	b			16.7			24.4			24.9
	c			15.0-18.4			23.2-25.6			20.2-29.6
prox radius/ulna	a	14	58.4	27.6	11.3	61.2	27.5	17.6	53.8	28.6
	b			32.2			31			34.8
	c			28.7-35.6			29.5-32.5			28.0-41.5
radius/ulna shaft	a	5.6	93.7	0.7	8.9	71.6	19.5	12.1	87	0.9
	b			0.7			21.2			1.1
	c			0.7-0.7			17.8-24.6			0.8-1.3
dist radius/ulna	a	16	66	18	12.2	67.3	20.5	20.9	53.6	25.5
	b			21.4			23.4			32.3
	c			19.7-23.1			22.3-24.4			29.4-35.2
prox metacarpal	a	11.8	83.6	4.6	8.4	81.3	10.3	9.6	81.2	9.2
	b			5.2			11.3			10.2
	c			5.1-5.3			10.2-12.3			8.9-11.4
metacarpal shaft	a	4.1	95.8	0.1	8.8	n/a	n/a	8	91.6	0.4
	b			0.1			n/a			0.4
	c			0.1-0.1			n/a			0.1-0.7
dist metacarpal	a	11.6	76.4	12	10.8	76.3	12.9	11.2	73.4	15.4
	b			13.6			14.5			17.4
	c			11.4-15.8			14.3-14.7			12.3-22.4
prox femur	a	16.9	55.4	27.7	13.2	58.3	28.5	11.9	63.3	24.8
	b			33.4			32.8			28.1
	c			32.7-34.0			29.8-35.8			22.6-33.6
femur shaft	a	8.2	85.9	5.9	5.8	89.4	4.8	6.5	82.8	10.7
	b			6.5			5.1			11.4
	c			4.4-8.5			3.6-6.6			4.3-18.5
dist femur	a	16.4	56.8	26.8	11.9	50.1	38	11.6	61.5	26.9
	b			32.1			43.1			30.4
	c			29.5-34.7			37.0-49.2			30.4-30.4
prox tibia	a	16.1	47.4	36.5	13.3	62.1	24.6	15.6	60.3	24.1
	b			43.5			28.4			28.6
	c			40.4-46.5			26.6-30.1			22.4-34.8
tibia shaft	a	8.8	90.2	1	6.6	88.7	4.7	4.3	94.5	1.2
	b			1.1			5			1.3
	c			1.0-1.2			3.0-7.0			1.2-1.4
dist tibia	a	11.5	81.1	7.4	13.1	70	16.9	10	76.7	13.3
	b			8.4			19.4			14.8
	c			7.9-9.9			17.8-21.0			14.2-15.4
prox metatarsal	a	12.1	83.2	4.7	9.4	78.9	11.7	n/a	n/a	n/a
	b			5.3			12.8			19
	c			4.9-5.7			9.9-15.7			14.5-23.5
metatarsal shaft	a	6.8	92.8	0.4	0	98.9	1.1	4.6	93	2.4
	b			0.4			1.1			2.6
	c			0.4-0.4			0.7-1.4			2.1-3.0
dist metatarsal	a	14.1	69.1	16.8	10.9	66.1	23	12	n/a	n/a
	b			19.5			25.8			n/a
	c			15.4-23.6			17.9-33.7			n/a

a= Mean % calculated from wet weight
b= Mean % calculated from dry weight
c= range of two subsamples, % of dry weight only

powder for each sample were then homogenized (deep gratitude to Milt Wright and Brian Kooyman for help with this ugly and thankless job). This homogenization ensured that, if certain parts of an articular end or shaft had differing amounts of bone grease, it would be blended to yield a more or less consistent reading from all parts of each bone sample.

Measuring the fatty acid content of the samples was done for us by Marc Cattet of the Department of Zoology, University of Alberta. Cattet subsampled the mixed (homogenized) bone chips produced for each articular end and midshaft portion and then used a solvent to extract the various fatty acids from the bone. Fatty acids were separated from the other constituent parts of the bone matter. The amount of total fatty acids, dry bone material and moisture for each articular end of the leg bones for three modern bison were measured. Two samples from each articular end were processed, and the average was taken.

Different specific fatty acids contained in the samples were not distinguished like Binford (1978) did for his grease index. Binford maintained that one fatty acid, Oleic acid, was the primary and best tasting acid in bone grease. This may be so; however, prehistoric hunters certainly had no way of separating any of the acids in bone grease. Hence, a measure of all fatty acids is a good indication of the amount of fat in the ends of the different leg bones. Also, Oleic acid is by far the most dominant fatty acid in the grease within all bones (Binford 1978:32; Hilditch and Williams 1964:98-109; Speth 1983:103); hence, a measure of all the fatty acids should parallel the measure of Oleic acid closely.

From Table 16, it can be seen that the leg bone portions richest in bone grease (total fatty acids) are the proximal humerus, the distal femur, the proximal radius and proximal tibia, with approximately equal amounts, and the proximal femur. The effect of the small sample size also can be seen. While most results are fairly consistent, some stand out as anomalous, such as the proximal tibia of animal 4 which had about 15 percent more fats than the other two specimens, and the distal femur of animal 84-11-1 which had over 10% more fats than the other specimens. Whether these anomalies represent animals in very different states of health or sampling errors will require additional testing to resolve.

It is also noteworthy that the midshafts of nearly all the leg bones contain very little bone grease, often only a few percent of the total bone material. One exception is the radius/ulna shaft of specimen 84-11-1 which recorded an average of 21.2% fats. This is so divergent from the other samples that the results of the assay should be suspect. In general, these results cast some doubt on the relative merits of pounding up bison leg bone shafts for the purpose of extracting bone grease. It is also interesting to note that the distal ends of the metapodials have about twice as much grease as their proximal counterparts.

Table 17 shows the volume (ml) of the articular ends of bison limb bones as measured from 4(+) bison in the reference collection of the Archaeological Survey of Alberta. The figures presented are the average for all bison measured, including two 6 year old males, one 3-4 year old male, one 2-3 year old female, plus miscellaneous long bone articular ends obtained from a local abattoir. This latter sample included a mix of bone portions from nine different animals, 7 females and 2 males, all in the age group of 2-3 years old. Not all leg bones were present from all nine animals, and it was not possible to keep separate the rights and lefts of each specific animal. Hence, this is known as a mixed lot but is still considered useful for documenting bison anatomy. Volumes for the articular ends were obtained by coating the ends with wax, immersing them in graduated beakers and measuring the displacement in millilitres. The limits of the area designated as the "articular end," for which the volume was measured, were determined by the beginning of the marrow cavity at each end of the shaft. This was marked on each bone so that a fairly consistent measure of volume was kept.

The proximal humerus had the largest volume of all measured articular ends (Table 16). The distal femur is similarly robust, followed after a fairly large drop in values by the proximal femur, the distal humerus and the proximal tibia. The smallest surface areas are associated with the proximal metapodials. These data are presented here to illustrate the potential size of reservoirs for bone grease in the limb bones, a factor which would likely be relevant in a hunter's decision to select a certain bone for processing.

Table 18 presents data on the size of the marrow cavities of bison leg bones and on the weight of the marrow plugs from these bones. The volume of the inside of the marrow cavities for the three bison described above was

Table 17. Mean values of the volume of modern bison leg bone articular ends.

Element	Mean Vol.(ml) Articular End
Proximal Humerus	596.25
Distal Humerus	291.44
Proximal Radius/Ulna	127.50
Distal Radius/Ulna	193.50
Proximal Metacarpal	76.00
Distal Metacarpal	95.91
Proximal Femur	358.00
Distal Femur	529.25
Proximal Tibia	289.00
Distal Tibia	86.67
Proximal Metatarsal	60.00
Distal Metatarsal	88.40

measured using water. Articular ends of the bones were sawed off, and one end of the shaft was sealed with plasticene. The cavity was then filled with water, and the volume of the water recorded. Each experiment was repeated five times to ensure that the water which became trapped in the cancelleous tissue of the bone had been accounted for. The weight of the marrow plug was taken shortly after the bone had been cut open. This helped prevent weight loss from dehydration. The weights given are for the total plug of marrow extracted from each bone. It was noted that, if the

Table 18. Weight of marrow and volume of marrow cavities in bison leg bones.

	No. 4		No. 84-11-1		No. 85-4-4	
	Wt.(g)	Vol. (ml)	Wt.	Vol.	Wt.	Vol.
humerus	96	110	86.8	93	113.6	126
radius	53.6	61	44.1	88	84.1	110
metacarpal	15.7	8	19.4	26	14	25
femur	104	142	n/a	124	95.5	147
tibia	89.5	106	98.1	133	95.3	138
metatarsal	16.2	n/a	22.4	27	17.7	17

bones were slightly cool, the marrow plug came out easily with little material clinging to the inner wall of the bone.

As expected, there is a fairly close correspondence between the weight of the marrow and the volume of the cavity. On average, the femur has the largest marrow cavity and the heaviest marrow plug. The tibia has the second largest cavity by volume, but the marrow plug of the humerus tends to weigh more than that of the tibia. The marrow of the metacarpal is both smallest in size and lightest in weight.

Once the volume and the weight of the marrow were established, the percentage of total fatty acids contained in the marrow was measured in the same way that the fatty acids contained in the bone structure were measured. Marrow samples from the leg bones were homogenized to blend any local variation in the fats within the length of the marrow cavity. Two subsamples were then extracted from the marrow of each bone. Marc Cattet used an ether solvent to extract the fatty acids from the dry matter and the water contained in marrow. The total percentage of fatty acids was calculated on a dry weight basis. The results of this analysis are presented in Table 19.

It is apparent from Table 19 that the great bulk of marrow is fatty acids. Although the exact percent clearly will vary with the time of year, the sex of the animal and the nutritional condition of the animal, in general, a normal healthy animal will have marrow composed mostly of fat. The variation of a few percent in the three animals sampled is too small to attempt to draw any conclusions from

The Modified General Utility Index (MGUI)

Binford's MGUI is a combination index which takes into account all the anatomical variables he examined in formulating the specific indices for meat, marrow and bone grease. Binford (1978:74, Table 2.7) produces figures for sheep and caribou general utility. Because these figures differ slightly, and because there is no compelling reason to select one over the other in the examination of bison bones, these values have been averaged to yield a single value for each element portion. Figure 46 plots the % MAU of the HSI limb bones against Binford's MGUI index.

Table 19. Percentage of total fatty acids contained in marrow of modern bison limb bones.

	No. 4			No. 84-11-1			No. 85-4-4		
	% Water	% Dry	% Fat	% Water	% Dry	% Fat	% Water	% Dry	% Fat
humerus (a	17.2	2.4	80.4	0	1.4	98.6	6	3.2	90.8
(b			97.1			98.6			96.6
(c			96.9-97.2			98.4-98.8			95.5-97.7
radius (a	16.8	2.9	80.3	9.5	7.9	82.6	5.9	2.2	91.9
(b			96.6			90.3			97.7
(c			96.3-96.8			86.1-94.5			95.4-100
metacarpal (a	11.8	4.4	83.8	6.3	1.5	92.2	3	n/a	n/a
(b			95			98.4			n/a
(c			94.8-95.2			97.8-98.9			n/a
femur (a	17.6	6.7	75.7	11.2	2.7	86.1	5.8	1.4	92.8
(b			91.9			97			98.5
(c			83.8-100			96.4-97.6			98.2-98.8
tibia (a	13.2	9.1	77.7	5.2	1.8	93	0	3.5	96.5
(b			89.5			98.1			96.5
(c			82.3-96.7			97.7-98.5			96.4-96.6
metatarsal (a	0	4.1	95.9	5.6	1.8	92.6	2.3	2.9	94.8
(b			95.9			98.1			97
(c			95.7-96.1			98.0-98.1			97.0-97.0

(a = Mean % as calculated from wet weight
(b = Mean % as calculated from dry weight
(c = range of two subsamples, % dry weight only

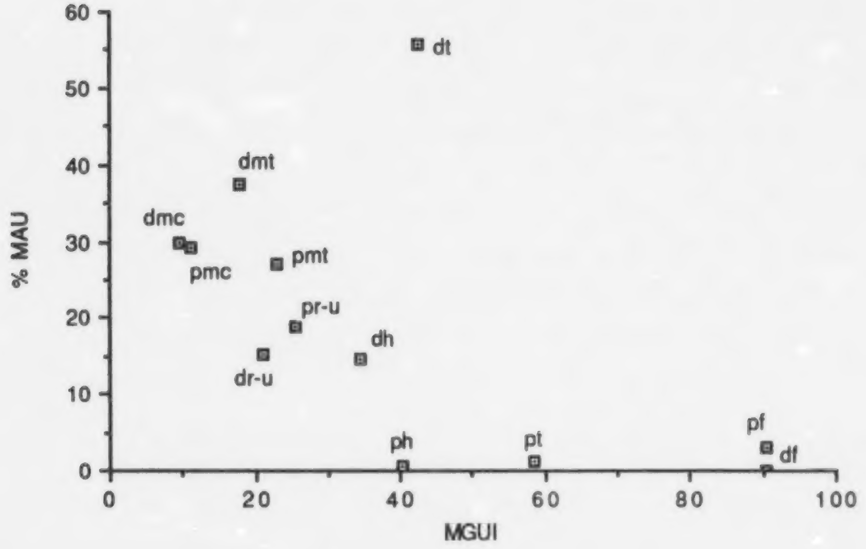


Figure 46. Comparison of Binford's MGUI with the % MAU for limb bones from DkPj-1.

The relationship between the MGUI and the % MAU for limb bones is far from perfect, yet it conforms to the general predictions of the index. The highest valued elements, according to Binford's combined criteria, are those least commonly recovered from the processing area, while the most common elements are recovered in greater proportion. Tentatively, it can be advanced that activities conducted at the site were aimed at maximizing the food value of the bison carcasses, at least with regard to the limb bones. Earlier in this section, it was seen that processes other than human faunal utilization can create an assemblage that mimics the patterns noted above; that is, the selective destruction or removal from a site of those elements which are both least dense and richest in food value. Thus, as Binford would note, we have observed the footprint, and it fits the prediction of the MGUI, but we have not directly observed the bear. Without being able to eliminate other potential causal agents of the observed faunal patterns, the suggested human maximization of the bison remains is, at this time, only an inference.

The Grease Index (GI)

It is also useful to examine our data in light of Binford's grease index. Evidence recovered from the HSI processing area strongly suggests that a major activity at the site was the transformation of fresh bison carcasses into storable foods. The preponderance of fire-broken rock and the pit features suggest that much cooking was done at the site. It can be assumed that at least some of these activities were intended to extract bone grease from elements rich in this food. If this was the case, the character of the assemblage should reflect the selective removal of preferred elements. Binford's GI is an attempt to model the decision-making process of carcass utilization to maximize bone grease recovery. We would expect that this index would show strong affinity with our data.

Figure 47 plots the % MAU of leg bones from HSI against Binford's grease index. As before, Binford's data for his two animals have been averaged to yield a single GI value (1978:33, Table 1.11, Column 6). The relationship is generally poor. While the element portions richest in bone grease, the distal femur, proximal humerus and proximal tibia, are least common in the assemblage, the remainder of the sample fails to conform to the predictions of the index.

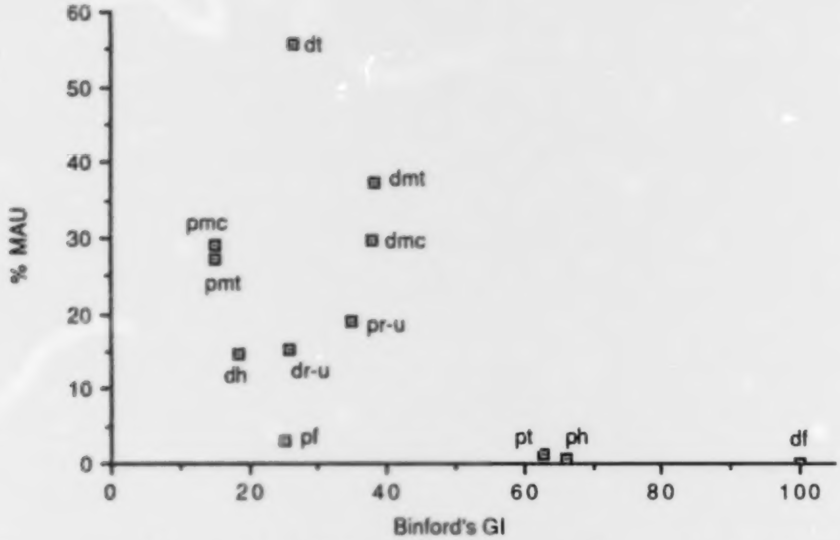


Figure 47. Comparison of Binford's grease index and % MAU for limb bones from DkPj-1.

Thus our data conform fairly closely with Binford's MGUI but not with his GI. Does this mean that utilization of fauna at HSI did not include the rendering of bone grease? In constructing his grease index Binford included the percentage of Oleic acid in each element, the density of the bone, the volume of the bone, and a measure of the processing time by the Nunamiut. Lyman (1984, 1985) has reviewed Binford's use of bone density data and has suggested that there were errors in Binford's methods and that he was not actually measuring bone density. In several recent articles, Jones and Metcalfe (1988) and Metcalfe and Jones (1988) have critiqued Binford's indices thoroughly and have pointed out additional errors in index construction. As well, they have asserted that some of Binford's variables were unnecessary. For example, they argue that Binford's inclusion of data on bone density adds nothing to the predictive power of the marrow index, and, in fact, the index is a better predictor of the selection of bones for marrow processing without the density value (Jones and Metcalfe 1988). These authors found that the simple measure of the amount of marrow in each element was the best predictor of the likelihood that any individual element would be processed for marrow.

Some of our anatomical data for bison, discussed above, can be used to form an alternate grease index. In turn, this can be compared to the results from Binford's GI, based on sheep and caribou. Relevant bison data include the volume of the articular ends of limb bones and the percentage of fatty acids in each articular end. Following the suggestion of Jones and Metcalfe (1988), bone density information, available for deer (Lyman 1985) but not yet available for bison, has been left out of the formation of a grease index for bison. To consider simply the relative size of each articular limb bone end, and the percentage of fatty acids contained in each end, seems consistent with the recommendation of Jones and Metcalfe (1988) that the simple measures of the amount of food value in each element likely will yield the most accurate index. Data for a revised index for rendering of grease specifically from bison bones are given in Table 20.

Table 20. Revised grease index for bison bones.

Element	Mean % Fatty Acids	Mean Vol. (ml) Articular End	Index Value*	Rank
Proximal Humerus	40.50	596.25	241.48	1
Distal Humerus	22.00	291.44	64.12	5
Proximal Radius/Ulna	33.50	127.50	42.71	7
Distal Radius/Ulna	25.70	193.50	49.73	6
Proximal Metacarpal	8.90	76.00	6.76	12
Distal Metacarpal	15.20	95.91	14.58	9
Proximal Femur	31.40	358.00	112.41	3
Distal Femur	35.20	529.25	186.30	2
Proximal Tibia	33.50	289.00	96.82	4
Distal Tibia	14.10	86.67	12.22	10
Proximal Metatarsal	12.40	60.00	7.44	11
Distal Metatarsal	22.70	88.40	20.07	8

*Index= %Fat X Vol./100

The index values for each element portion are derived simply by multiplying the percent fatty acids by the bone volume, divided by 100. In his indices, Binford standardized the figures by dividing all other values by the value of the highest scoring element. This operation gives the highest valued element a score of 100 and all other values ranked accordingly. Metcalfe and Jones (1988) have argued that this is an unnecessary and potentially distorting procedure which can detract from the power of the index. Accordingly, no attempt has been made to standardize the values in the new index which range from a high of 241.48 for the proximal humerus to a low of 6.76 for the proximal metacarpal. Table 6-16 also gives the rank of each element portion within the grease index.

This revised index can now be compared, as was Binford's, to a measure of the proportional frequency of limb bones from the HSI processing area. The percent of the minimal animal unit (% MAU) again is the measure of faunal abundance used. Figure 48 shows the relationship between the new grease index and the abundance of limb bone portions.

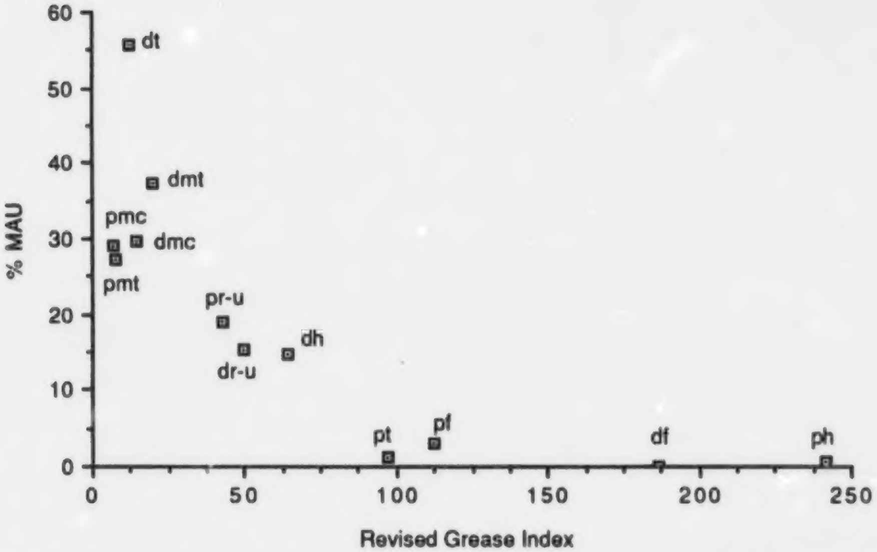


Figure 48. Relationship between a revised grease index for modern bison and % MAU of limb elements, DkPj-1.

It is evident that a much stronger relationship exists between the revised index, based on percent fatty acids and articular end volume, than was achieved with Binford's grease index, based on caribou and sheep anatomy. Element proportional frequency at the site fits closely with what would be predicted if there had been selective removal of bones with the largest and most concentrated reserves of bone grease. It must be cautioned again, however, that other agents could produce similar patterns of element frequency and that the close correspondence between the new index and the recovered fauna is not proof of a causal relationship.

Perhaps more important than the actual results achieved with the revised index is the indication that quite different conclusions can be reached regarding prehistoric faunal utilization than were drawn when we employed Binford's index. This is significant in light of the growing number of studies which have used Binford's indices for the analysis of materials other than sheep or caribou, and it emphasizes the need for continued research with economic anatomical studies of other large mammals. One such study which is clearly needed is a measure of the density of bison bones. Although Jones and Metcalfe (1988) suggest that this variable may not be needed in the construction of anatomical indices, it is clearly a significant factor in assessing the survivability of bison bones at kill/butchery sites. This is especially important at HSI where various lines of evidence suggest that severe taphonomic agents have operated on the assemblage. Currently, we are measuring bison bone density following the methods outlined by Lyman (1982). These data are not yet available. It is interesting to note, however, that a strong relationship exists between bone density, as measured for deer bones by Lyman (1982), and the revised grease index presented here (Figure 49). Clearly, attributes of the volume of a bone, the amount of fats contained in a bone, and the density of that element are interconnected. Furthermore, all of these attributes likely contributed to the decision-making processes regarding the selective processing of bison carcass material. No doubt additional research will elucidate these complex relationships.

The Marrow Index (MI)

As with bone grease content, the leg bones recovered from HSI can be compared to Binford's (1978) index for marrow processing. Binford's marrow index, based again on sheep and caribou data, has been questioned by a number of researchers. Binford considered the volume of the marrow cavity, the percentage of Oleic fatty acid in all fatty acids in the marrow, and the relative ease or difficulty of obtaining this food source. After a thorough review, Jones and Metcalfe (1988) conclude that much of this information is irrelevant. Taking only Binford's data on the volume of the cavities, they produce a new index which fits Binford's own criteria for

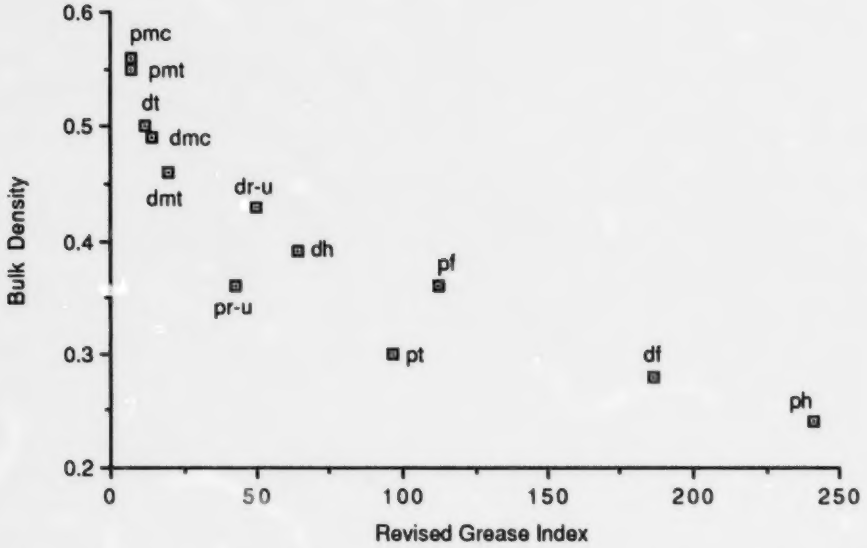


Figure 49. Relationship between the bulk density of deer limb bones and the revised grease index for bison. (Density data are from Lyman [1982].)

evaluation better than Binford's more complex scheme. Jones and Metcalfe suggest that sheer volume of marrow likely would be the prime determinant in selecting bones for processing. Furthermore, a number of errors and unexplained measures included in Binford's marrow index have detracted from the utility of this measure (Brink 1986; Jones and Metcalfe 1988). It should also be noted that the extraction of marrow from portions of large mammal leg bones seems unlikely. Binford's (1978:27) marrow index distinguishes between proximal and distal portions of caribou and sheep leg bones. Yet to retrieve the marrow from any of these bones does not favour one end over the other, and the archaeological residue of marrow removal should be similarly unbiased. It is highly unlikely that any hunter would crack open a long bone, remove marrow from one half and throw the other half away. Thus, the presence of either end of one of the major limb bones should indicate processing of that entire element for marrow.

Binford also considers which bones would be most highly prized for their marrow content. To test his proposed index, he employs the contemporary marrow processing actions of the Nunamiut. In itself this is fine, but it skirts the critical issue of archaeological relevance. It must also be asked what is the archaeological signature of bone marrow recovery? In the case of bone grease rendering, it can be argued that, because of the crushing involved, the selected bones will tend to be scarce or will disappear from the archaeological record. Thus, the relative frequency of element portions can be interpreted as evidence for the preferential selection of certain elements for bone grease rendering.

In the case of marrow extraction, however, the most important bones, the leg bones, will be broken at one or more places along the shaft to retrieve the marrow. The archaeological residue of this effort (temporarily excluding all other factors which could further destroy the bone) will be numerous articular ends with attached portions of freshly broken shaft and numerous shaft splinters. The bones, at least the articular ends, will not "disappear" from the archaeological record simply because the marrow cavity has been broken into. Shaft splinters should be found in abundance, but, as noted at HSI, frequently these cannot be identified to a specific element. Thus, the relative frequency of articular ends will not necessarily indicate which bones were more and less desirable for marrow. A more meaningful measure would be a comparison between the relative percentage of each bone found complete (or a complete shaft) as opposed to proximal and distal fragments of the same elements. Unfortunately, it has already been noted that almost no complete bones were recovered from HSI.

The question remains how to evaluate an archaeological assemblage so as to determine if marrow processing was a significant activity. Green bone fractures have been observed in the HSI assemblage. It is equally possible, however, that these fractures were produced when bones were being broken for grease rendering as for marrow removal. Thus, green bone fractures alone are not indicative of bone marrow recovery. At a bison kill/butchery site, it can be argued that the decision to remove certain elements from the kill location can indicate a desire to recover the marrow from these elements and that the relative frequency of each element is an indication, in part, of the value of that element as a source of marrow. Yet it is also known that hunters sometimes cracked open bones and consumed bison marrow during the course of butchering as a source of quick energy (see Verbicky-Todd 1984). This would result in prized marrow bones also being distributed at the kill. Furthermore, it cannot be argued that differential transport of bones from a kill reflected a concern with recovery of marrow rather than bone grease.

In reality, the treatment of bones at many bison kill/butchery sites cannot be segregated into uses specific to a particular index. Undoubtedly, many bones, especially limb bones, were earmarked for both marrow and grease rendering. The shafts of limb bones were cracked to recover marrow, and certain articular ends were then crushed to boil for grease rendering. Shaft splinters (resulting from marrow removal) contain very little fat and likely were not processed further for grease rendering, although they might be tossed into a boiling pit if one was handy. Likewise, certain articular ends likely were ignored, since their greater density dictated both a low fat content and greater difficulty in processing. These ends also may have been tossed into a boiling pit without further modification or may have been abandoned on the prairie. Thus, although relevant data from bison are available (volume of marrow cavity, weight of marrow, percent of fatty acids in marrow), there seems little point in constructing a new marrow index for bison. Without a method to apply an archaeological assemblage to the index, there seems little potential to arrive at results which can be attributed unambiguously to the quest for marrow.

It is possible to compare the relative frequency of leg elements with some attribute which presumably reflects the value placed upon recovery of marrow. Figure 50, for example, compares the volume of the leg bone marrow cavities with the % MAU from the HSI processing area. With the exception of the effect of a great number of distal tibiae recovered, the overall relationship seems strong. Bones with the largest marrow cavities are least commonly recovered. But since marrow removal does not destroy articular ends of the bones, and since identifiable shafts were rare at HSI, what does the comparison in Figure 50 really tell us? We suggest that the message is not one of which bones are being broken preferentially for marrow removal.

The Bone Utility Index (BUI)

Since marrow removal likely is part of a continuum of bison processing (closely related to grease rendering), and since there is no real archaeological signature that clearly separates these activities, it seems

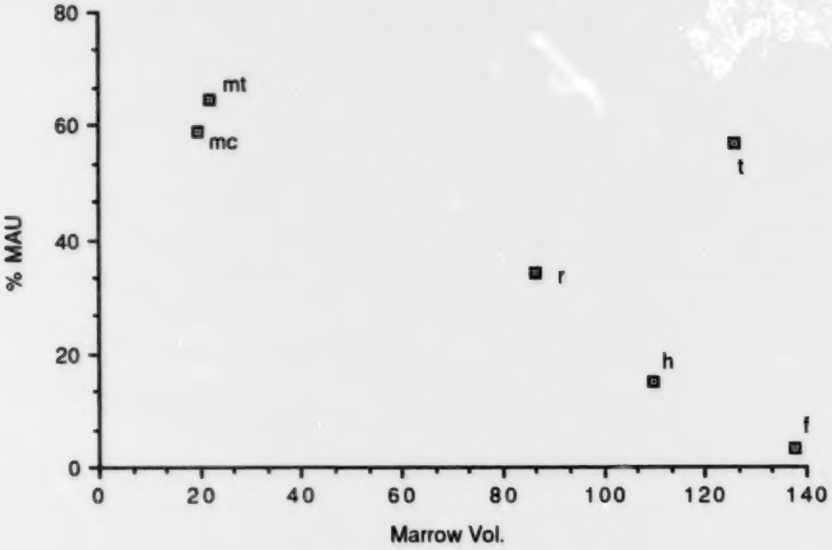


Figure 50. Comparison of bison marrow cavity volume with % MAU, DkPj-1.

reasonable to combine the two food values of bison leg bones into a single index. Such an index is presented in Table 21.

This index considers the two variables deemed most likely to be important to prehistoric hunters: the amount of the food source (volume) and the nutritional benefit of the food (percent fatty acids). The index is referred to as the Bone Utility Index (BUI) and is formed by multiplying the percent fatty acids by the volume of the bone portion and dividing by 100. For the articular ends, the index scores are identical to those already presented in Table 20. This is because the addition of marrow data does not affect the index values (based on grease content and volume) of the articular ends. Incorporating marrow data has a great effect on the relative utility of the shaft portion of the leg bones, however. In Table 21, the volume of the shaft portions refers to the inside measurement of the marrow cavity, and the percent of total fatty acids is a combination of the percent fats found in the actual bone tissue of the shafts and of the fat contained in the marrow plug. Because these values are combined, totals will sometimes exceed 100%. The net effect is to increase the importance of the bone portions associated with largest marrow cavities, especially the shafts of the femur, tibia and humerus. These three element portions now rank among the top

Table 21. A bone utility index for bison.

Element	Mean % Fatty Acids	Mean Vol. (ml.)	Index Value	Rank
Proximal Humerus	40.5[†]	596.25	241.48	1
Shaft Humerus	101.03[*]	109.67	110.80	6
Distal Humerus	22.00	291.44	64.12	9
Proximal Radius/Ulna	33.50	127.50	42.71	11
Shaft Radius/Ulna	95.80	86.33	82.71	8
Distal Radius/Ulna	25.70	193.50	49.73	10
Proximal Metacarpal	8.90	76.00	6.76	18
Shaft Metacarpal	96.95	19.67	19.07	14
Distal Metacarpal	15.20	95.91	14.58	15
Proximal Femur	31.40	358.00	112.41	5
Shaft Femur	103.46	137.67	142.43	3
Distal Femur	35.20	529.25	186.30	2
Proximal Tibia	33.50	289.00	96.82	7
Shaft Tibia	97.17	125.67	122.11	4
Distal Tibia	14.10	86.67	12.22	16
Proximal Metatarsal	12.40	60.00	7.44	17
Shaft Metatarsal	98.37	35.50	34.92	12
Distal Metatarsal	22.70	88.40	20.07	13

[†] Includes only the fatty acids measured in the articular ends.

[*] Includes total fatty acids measured in the bone of the leg shafts as well as within the marrow.

six choices of bison leg bones. Before, based solely on fatty acid content in the bone tissue (Table 16), all of these element portions were among the least desirable choices of the limb elements.

To utilize this new bone index fully requires an archaeological sample that includes shaft portions of bison limb bones. Such is not the case at HSI. Plotting only the articular ends against the bone index will yield exactly the same results as seen in Figure 48. This is because the revised grease index and the BUI consider the same data for these element portions - volume and fatty acid content. Other researchers may wish to employ the BUI in an attempt to interpret faunal assemblages which have better representation of shaft portions.

It is possible to combine all the values listed in Table 21 for each limb bone portion to produce a single value for each major bison leg bone. Figure 51 plots these single bone values, an overall assessment of the food utility of the bones, against the relative frequency of these bones in the HSI assemblage. Because the % MAU values in this figure need to reflect the recovery of all portions of each element, not just the articular ends, the % MAU values have incorporated the data from Appendix 2 regarding the complete shaft portions (minimal as they are).

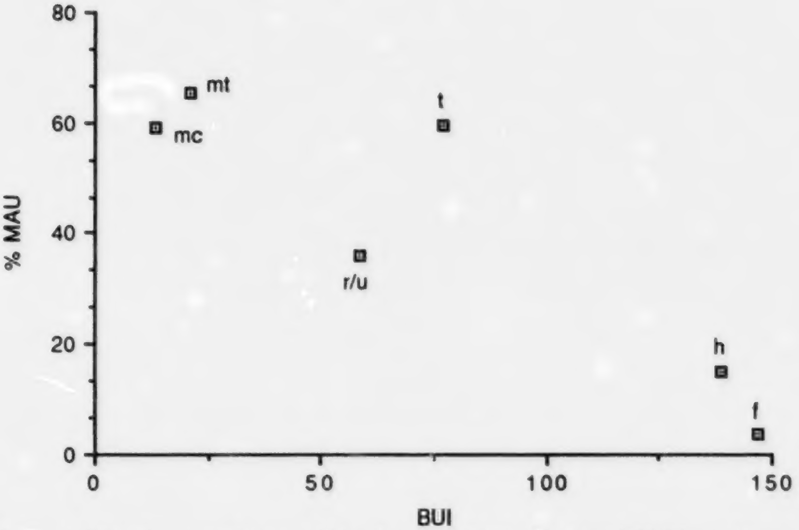


Figure 51. Comparison of the bone utility index (BUI) and the relative frequency of limb bone elements from DkPj-1.

The relationship between the BUI and the recovery of major limb bones is relatively strong. Bones highest in the index were the least common, and those of lowest nutritional quality were most commonly recovered. As has been noted before, the high frequency of distal tibiae has elevated the % MAU for this element beyond what the index would predict. In general, however, it would appear that the BUI offers some hope of helping to explain differential faunal representation at bison kill/butchery sites. Still, the size of the sample of anatomical data which went into the construction of the index is small, and, thus, it may be flawed. More animals, killed in different seasons, of different sexes, and so forth need to be considered for the construction of a truly valid index.

The present effort is an initial attempt to examine the faunal remains of bison with indices constructed from bison anatomy rather than from caribou and sheep. The indication is that, at least for some variables, there are considerable differences between the anatomies of these animals. Furthermore, there is some evidence (i.e., the revised grease index) that indices based upon bison anatomy are more accurate predictors of the utilization of bison carcasses than are indices based on other animals. If correct, these suggestions have an important bearing on the widespread use of Binford's indices in the analysis of faunal materials other than those for which the indices were formed.

The Spring Channel

The brief tests conducted in the spring channel which flows from, and bisects the kill site were not intended as an attempt to sample the kill site faunal deposits. Rather, we speculated that there may be an opportunity to recover perishable, organic materials from the saturated deposits near the head of the channel. Still, a fairly large sample of well-preserved faunal remains was recovered from these pits and is reported on here. This was not our first testing of the spring channel. In 1983, R. Morlan spent several weeks with our crew directing the excavation of a single test unit on the south side of the channel. This unit, located about 75 m down channel from the site of the 1985 tests, was intended to sample the faunal materials in the stratified walls of the channel; it was not intended to recover perishable materials. The results of this first test have been reported elsewhere (Morlan 1985).

Two 1 x 1 m units located in the channel bottom (see Figure 3) were excavated to depths of 1 and 1.5 m. Standing water was encountered in both units, at a depth of about 30 cm in the upper unit (39) and at about 1 m in the lower unit (40). Because we were not equipped for wet screening, recovery was difficult, and no doubt some small bones were missed in the mud. However, since the elements were in better condition and larger overall than those of the processing area, the number of elements that were overlooked is probably small.

In total, 537 bones were recovered from the two units. Appendix 3 presents the complete list of elements and element portions by NISP. An abbreviated version with % NISP is given in Table 22. Differences between this assemblage and that of the processing area are strikingly apparent. First, including the isolated teeth, nearly 70% of the spring channel assemblage is from the axial portion of the skeleton. Skulls make up the largest percent of the NISP count, and, although none was fully complete, many were large portions of the element. Most basio-occipital regions were nearly complete, as were horn cores and maxilla. Five of 29 mandibles were complete, compared with only 1 of 119 mandibles from the processing area. Nearly one quarter (23.48%) of all elements are vertebrae, and, of these, 47 (37.9%) were complete. Only four complete vertebrae were recovered from the processing area. Four complete ribs came from the spring channel, while none has ever been found on the prairie level.

Appendicular elements show similar reverse patterns from the processing area. Carpals and tarsals, so dominant in the prairie assemblage, account for only 7.97% of the spring channel material. Phalanges, on the other hand, form a fairly important component (7%) of the latter assemblage. Six of 19 scapula were complete, compared to 1 of 181 scapula from the prairie. Although the sample is small, most of the major limb bones exhibit a greater representation of both articular ends. The number of proximal tibiae, for example, nearly equals that of the distal end (6:7), whereas, from the processing area, the ratio for these same portions was heavily skewed to the distal end (37:159). From Table 22, it also can be seen that fragments were almost non-existent in the channel deposits, composing less than 2% of the assemblage. Fragments made up over 12% of the processing area assemblage. Figure 52 illustrates the differences between the spring channel and processing area assemblages by plotting the % NISP for a selection of 16 elements from the skeleton.

Apparent in Figure 52 is the break between axial and appendicular elements, where channel material dominates in the former, especially in skull and vertebrae elements, and prairie material in the latter, especially in carpals, tarsals and phalanges. A more precise breakdown of the axial elements, compared to the assemblage from the prairie, is shown in Figure 53.

The near absence of hyoids from both assemblages may be the result of removal of the tongues at the kill site. This food item was one of the most desirable and important in Plains Indian society (Verbicky-Todd 1984:168-184), and its relative scarcity has been noted at other communal kills

Table 22. NISP, DkPj-1, 1985 spring channel units 39 and 40.

	NISP ALL LEVELS	
ELEMENT	#	%
Skull	86	16.29
Mandible	29	5.49
Hyoid	3	0.57
Atlas	7	1.33
Axis	9	1.70
Cervical vert	44	8.33
Thoracic vert	31	5.87
Lumbar vert	25	4.73
Sacrum	5	0.95
Caudal vert	3	0.57
Rib	36	6.82
Sternabra	0	0.00
Pelvis	34	6.44
Scapula	19	3.60
Humerus	9	1.70
Radius	9	1.70
Ulna	2	0.38
Scaphoid	3	0.57
Lunate	5	0.95
Cuneiform	3	0.57
Pisiform	1	0.19
Magnum	6	1.14
Unciform	2	0.38
5th Metacarpal	0	0.00
Metacarpal	8	1.52
Femur	10	1.89
Patella	3	0.57
Tibia	17	3.22
Lateral malleolus	1	0.19
Astragalus	10	1.89
Calcaneus	7	1.33
Navicular cuboid	4	0.76
Cuniform pes	0	0.00
1st tarsal	0	0.00
2nd tarsal	0	0.00
Metatarsal	5	0.95
1st phalanx	14	2.65
2nd phalanx	18	3.41
3rd phalanx	5	0.95
Proximal sesamoid	4	0.76
Distal sesamoid	0	0.00
Upper tooth	23	4.36
Incisor/canine	3	0.57
Lower pre/molar	24	4.55
ELEMENT NISP	**527**	**100%**
FRAGMENTS		
Metapodial	5	50
Longbone fragment	0	0
Costal cart	0	0
Scapula cart	0	0
Skull fragment	1	10
Tooth fragment	0	0
Rib fragment	0	0
Vert fragment	4	40
pes/manus	0	0
Indeterminate	0	0
FRAGMENT NISP	**10**	**100%**
TOTAL COUNT	**537**	

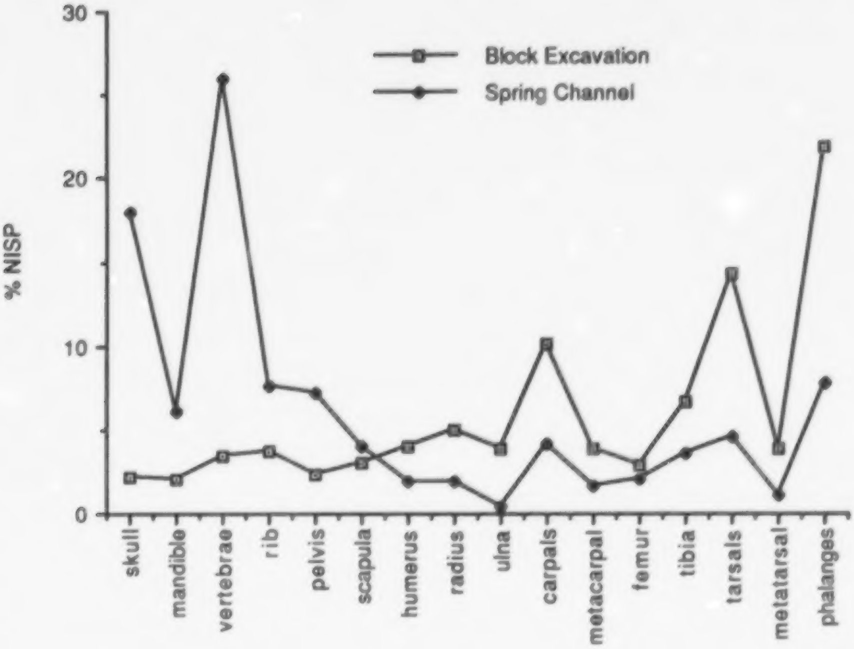


Figure 52. % NISP of elements from the spring channel compared with the block excavation of the processing area, DkPj-1.

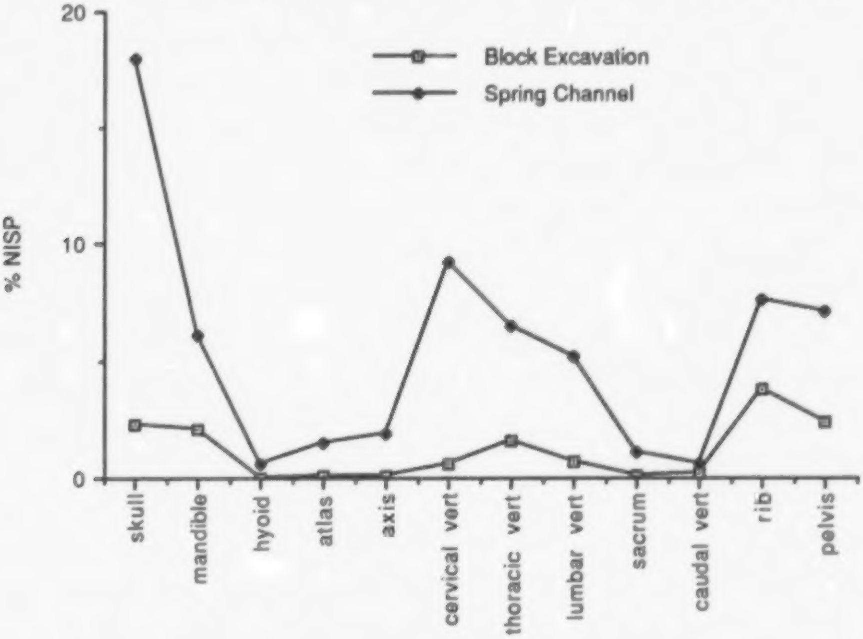


Figure 53. % NISP of axial material from the spring channel and the processing area, DkPj-1.

(Frison 1970, 1973). The caudal vertebrae are also rare in the spring channel assemblage. Again, this presumably reflects the failure to remove the tail bones from the hide.

Aging of all HSI faunal material will be discussed below, however, it is worth noting here that approximately half of the spring channel fauna could be assigned an age category. This is a much higher percentage than was the case with the block excavation. Nine bones (1.7%) from the spring channel were identified as foetal, 77 (14.3%) as immature, and 179 (33.3%) as mature. The incidence of foetal bone, although still low, is substantially higher than that of the processing area where 25 (0.34%) bones were identified as foetal. This is likely due to the improved preservation of the channel deposits. It is also possible that foetal carcasses, because of their small size, were completely dressed out at the kill site, thus accounting for the increased percentage of these bones in the channel.

Sexing

Because of the extreme fragmentation and degradation of the Head-Smashed-In faunal assemblage, sexing of many of the elements is difficult or impossible. In some cases, so few specimens of bones or portions of bones are available that sexing would be of little value. Fortunately, in the past few years, a number of researchers have proposed techniques specifically designed for sexing bison remains, especially partial elements (Speth 1983; Todd 1986, 1987; Walde 1985). These techniques, developed on the basis of measurements on known sex specimens, are possible because of the considerable sexual dimorphism between male and female bison (Reynolds *et al.* 1982; van Zyll de Jong 1986). Most commonly, sexing is attempted on the limb bones, although Speth (1983) appeared to have considerable success sexing nearly every skeletal element.

Sexing of prehistoric bison specimens using data from modern animals requires an assumption of consistent sexual dimorphism through time. Considerable changes in bison size have been documented during Late Pleistocene and Holocene times (McDonald 1981; Skinner and Kaisen 1947). The Holocene dwarfing of bison did not cease with the rise of modern *Bison bison* but apparently has continued right up until relatively recent times (Wilson 1978, 1980). Thus, although the Head-Smashed-In fauna from the processing area almost certainly dates to within last 1,800 years, these populations likely were somewhat larger that the animals upon which the sexing techniques are based. However, a recent taxonomic study of the genus provides excellent evidence to support the contention that the gradual dwarfing of bison has not changed the relative proportions of skeletal elements substantially (van Zyll de Jong 1986). For example, Todd (1987) sexed bison elements from an early Holocene kill site and found that females sometimes overlapped the size range of modern males, yet the males from the site likewise were substantially larger than their modern counterparts. It seems fair to conclude that Holocene changes in bison size have not precluded the ability to accurately sex the skeletal elements.

In many cases, it now appears that bison bones can be sexed accurately using as few as two measurements of the articular ends of limb bones (Todd 1986). This permits the sexing of many fragments that previously would have been ignored. Unfortunately for our purposes, Todd (1986) reports that sexing of bison bones diminishes in accuracy as one moves distally along the limbs. This means that our most common elements, carpals, tarsals, phalanges and metapodials, are less reliable elements for sexing. Admittedly, however, there has been little attempt to sex the carpals and tarsals. This is an area where further research could be most useful in the analysis of bison processing, as opposed to kill, sites. Roberts (1982) reports success sexing bison phalanges, these results have not received widespread acceptance.

The major constraint in sexing of elements for the Head-Smashed-In processing assemblage is having a large enough population of complete portions (MNE) of the upper (proximal) limb bones to produce meaningful results. A few samples do offer sufficient numbers to provide a tentative view of the sex composition of the butchered herds. Specimens complete enough to permit satisfactory measurement include the proximal radius (n=53), the distal tibia (n=53) and the distal humerus (n=22). It should be noted that occasionally measurements were taken of broken specimens held together. This was done only when it was felt that the fit of the pieces was sufficient to yield an accurate measurement. Measurements were only taken on mature (fully fused) elements. To keep the sample as large as possible lefts and rights were both measured. This may have resulted in duplication of some individual animals. Given the scatter of bones at HSI, however, it is felt that this possibility is unlikely, and that the approximate sex ratios will not be affected. Data for all measurements are given in Table 23.

Table 23. Data from sexing of distal humerus, proximal radius and distal tibia, Head-Smashed-In material.

Measurement	Mean	Min.	Max.	Std. Dev.	Var.
HM 7	82.18	74.59	97.8	5.99	35.91
HM 11	93.63	80.75	110.68	7.3	53.29
RD 4	68.83	63.84	78.89	4.05	16.37
RD 9	49.44	45.88	57.54	2.91	8.46
Tibia "H"	82.89	74.84	98.25	6.64	44.14
Tibia "I"	44.07	35.58	51.91	4.58	20.93

The measurements for the distal humerus and the proximal radius follow the methods outlined by Todd (1986, 1987), using the measurements he reports as being the most sensitive discriminators of the sexes. The measurement of the distal tibia follows that proposed by Speth (1983). The specific measurements taken are defined as follows and are illustrated in the upper portions of Figures 54, 55 and 56.

Humerus:
HM7: Greatest breadth of distal articular surface
HM11: Greatest depth of the distal end
Radius:
RD4: Greatest breadth of the proximal articular surface
Tibia:
RD9: Greatest depth of the proximal end
Dist Breadth "H": Greatest breadth of distal end
Dist Depth "I": Greatest depth of distal end

In general, the measurements taken appear to have separated the majority of males and females. For the largest sample, the proximal radius, the data suggest that 36 (67.9%) specimens are female; 12 (22.6%)

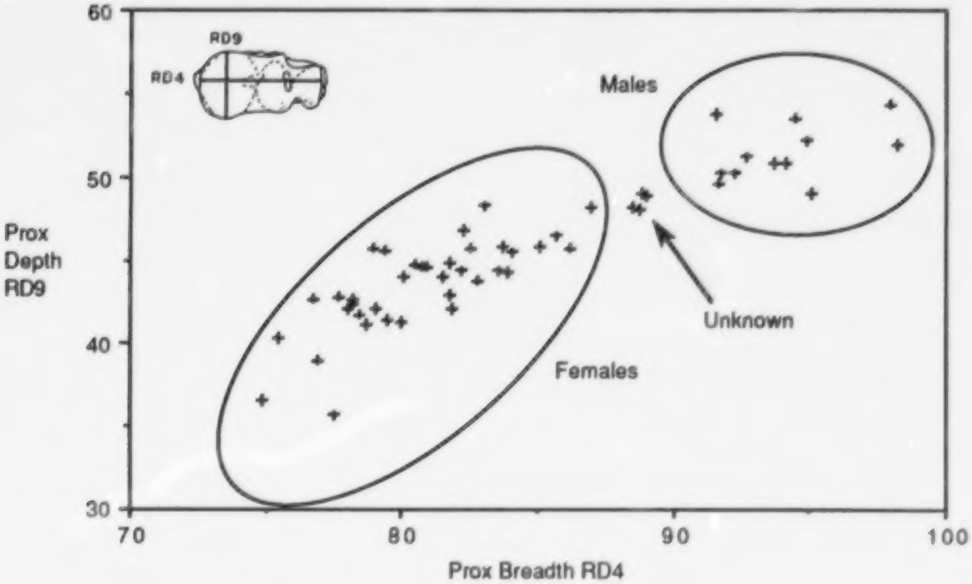


Figure 54. Sexing of the proximal radius, DkPj-1.

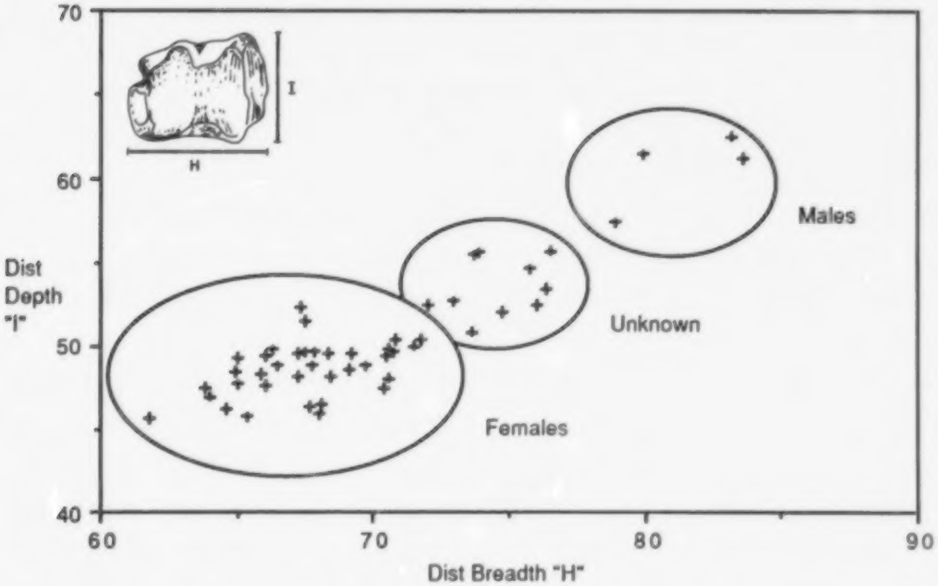


Figure 55. Sexing of distal tibia, DkPj-1.

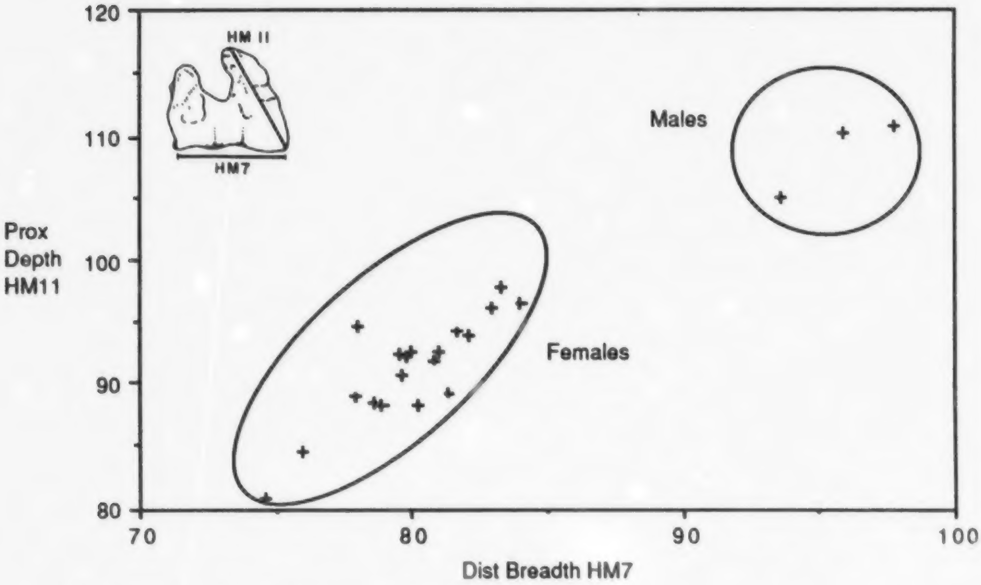


Figure 56. Sexing of distal humerus, DkPj-1.

are male; and 5 (9.4%) are of unknown sex. These results suggest a population dominated by females by a ratio of 3:1. The unknown specimens fall midway between the two clusters and do not lend themselves to a "probable" assignment. For the distal tibia, the results are 36 females (72%), 4 males (8%), and 10 unknown (20%). In this case, we suspect that a number of the unknown specimens could be included as females, but this remains equivocal. A sex ratio of about 9:1 is indicated by the tibia results. The distal humerus yielded the greatest separation between specimens interpreted as males and females. Nineteen elements (86.4%) are considered females, three (13.6%) males, and none are unknown, for a sex ratio of about 6:1. In general, 75% of all sexed elements were identified as female.

Assuming that these sexed elements are representative of the population of animals butchered at the site, the results support the generally held belief that most communal bison kills on the northern Plains were aimed at capturing cow/calf herds (Frison 1970, 1973, 1974, 1978; Reher and Frison 1980). Sexing of elements at other communal bison kills also has indicated a strong predominance of females among the kill population, with females usually averaging around 80% of the sexed population (Reher 1970, 1973; Reher and Frison 1980; Todd 1987). Elements from previous excavations at the Head-Smashed-In processing area also suggested a strong dominance of females (Brink *et al.* 1986).

Frison (1970, 1974) has argued that this female focus is intentional, a reflection of the fact that cow/calf herds behaved in the manner required for a successful drive; that is, these groups were responsive to the gathering and driving procedures characteristic of the communal kills, whereas the more solitary bull groups were not. Cow/calf herds have been shown to operate as a collective unit, whose defense when threatened is to run in a tightly packed herd away from the perceived threat. This is ideal, or perhaps required, for a successful drive. Bulls, on the other hand, are more prone to independent behaviour, resisting a drive and confronting an enemy (Fuller 1966; McHugh 1958; Reynolds *et al.* 1982; Soper 1941).

Furthermore, Frison (1970, 1973, 1974, 1978) has argued that most communal kills are events of the fall season, since this is the season when great stores of food are needed for the coming winter. This coincides with the time of year that the females and calves have regrouped after the summer rut (Frison 1974:14-21; McHugh 1958). The females are known to be in prime condition in the fall, with the highest levels of fat and the thickest coats (Speth 1983). Thus, one could interpret the sexing evidence from Head-Smashed-In as indicating a fall kill/butchery event. This is highly tenuous, of course, since there is no direct evidence of the seasonality of site use. Furthermore, similar cow/calf groups would have persisted throughout the winter and early spring. It may be fair to conclude that, while the sexing of the elements does not dictate a particular season of kill, it does suggest that the summer was the least likely time of the kills.

On the other hand, the work of Speth (1983) at the Garnsey bison kill site has demonstrated the fallacy of accepting a few sexed elements as indicative of the entire kill population. By sexing a great number of skeletal elements from this extraordinarily well preserved spring kill assemblage, Speth was able to show that there were wide variations in the male/female ratios of different elements. Had only a few select elements been sexed, the results would have indicated a strong female bias in the kill assemblage. By sexing numerous elements, Speth demonstrated that this apparent bias was transformed through preferential butchering of male carcasses, apparently a result of the enhanced nutritional value of the males in the spring.

Unfortunately, Head-Smashed-In lacks the faunal resolution necessary for such an extensive sexing of the skeleton. The three elements examined are the only samples which are large enough and for which reliable techniques are available. However, it may be noteworthy that, of the 128 bones subjected to sexing analysis, seven were recovered from the spring channel and these few bones suggest a more even sex ratio. Three of the seven are female; three are male; and one is unknown. Since the spring channel fauna originate directly from the kill site deposits, does this mean that the kill assemblage was more evenly composed of both sexes and that the skewed remains at the processing area reflect selection of females to be brought to the processing area? Clearly, seven elements is too small a sample on which to base such a conclusion. Yet it suggests an interesting problem for future research.

In sum, the data suggest that the butchering of bison at Head-Smashed-In focussed on female carcasses. Moreover, and more tenuously, it can be posited that these kill/butchery events were not likely conducted in the summer months. Even more tenuously, there is very slim evidence to suggest that the sex ratio at the original kill site may have been more even and that processing focussed on females from this larger population.

Aging

No attempts are made here to analyse the age structure of the bison population recovered from the 1985/86 excavation at Head-Smashed-In. To employ the age determination methods often utilized at other communal kills (e.g., Reher 1970, 1973; Reher and Frison 1980) requires faunal material unavailable to us. With one complete mandible out of over 7,000 bones from the processing area, there is little point in pursuing the methods that rely on this element. Although isolated molars are available in larger numbers, use of isolated teeth is unsatisfactory because it precludes age estimates based on eruption sequences, thus eliminating the younger animals. Reher and Frison (1980:62) state that juvenile mandibles are the key to accurate age and seasonality determinations because of the fine resolution offered by these elements. Maxilla and upper teeth have been used for age and season determination at the Big Goose Creek site (Frison *et al.* 1978). Again, however, the sample of relatively complete maxilla (n=2) from the HSI processing area is insufficient. Isolated molars from mature animals would have to be examined for tooth wear, and the sample of teeth is in the same poor condition as the rest of the bone. Measuring crown height on the M1 metaconid (Reher 1973:92) would require samples of well preserved molars. Almost all of the HSI isolated teeth have suffered some degree of deterioration and could not be counted on to yield reliable age estimates.

The only information presented here on general age structure of the butchered population comes from relative assessment of gross age groupings. Still, the fragmentary nature of most of the bone precludes much in the way of even gross age analysis. Most bones simply lack any definitive evidence of age. While it was often felt that a specimen probably came from a mature or an immature animal, this was little more than a guess based on the general size of the bone. Lacking clear evidence of approximate age, a conservative approach was taken, and approximate age categories were assigned only when a clear indicator was encountered. Most often, this consisted of evidence of bone fusion. Evidence of full fusion of articular surfaces was taken as an indication of a mature animal, while evidence of no or incomplete fusion was assigned to the immature category. Bones were also classified as foetal and indeterminate. Table 24 presents the age information for the various excavation areas from 1985/86.

As can be seen, the vast majority of all fauna is of unknown age. The greatest success in assigning an age grouping to a sample was in the spring channel, where nearly 50% of the material was classified into one of the three age groupings. This likely results from the enhanced preservation of bone in the channel. For the block excavation as a whole, about 72% of all fauna could not be assigned to an age class.

The ratio of mature to immature specimens from the block area is about 3:1, although slightly lower (2.3:1) from the spring channel. It is difficult to know if this reflects the true nature of the herds. Taphonomic factors may be more likely to remove immature specimens from the sample selectively, and, because of the less durable nature of immature bone, more of the unknown specimens may be from this age group.

Table 24. Number and percent of general age classes from 1985/86 excavations, DkPj-1.

	Foetal(#/%)	Immature	Mature	Indeterminate	Total
Block Excavation (minus features)	24/0.4	403/6.2	1409/21.5	4719/72.0	6555
Features Only	1/0.2	43/7.3	119/20.1	428/72.4	591
Upper Stratum	15/0.4	215/6.3	520/15.1	2691/78.2	3441
Lower Stratum	1/0.27	15/4.1	40/11.2	307/84.6	363
Spring Channel	9/1.7	77/14.3	179/33.3	272/50.7	537

Aging studies at other Plains bison kills often have documented a disproportionately small number of immature or juvenile animals relative to what would be expected in a catastrophic kill population. At the Wardell site, Reher (1973:97) reports that a large number of juvenile animals are missing from the site population. The same is said to be true at the Glenrock Buffalo Jump (Reher 1970:53) and at the Vore site (Reher and Frison 1980:92). These authors attribute this pattern to selective removal of young animals from the kill and butchering sites. Selection of young is said to be a result of the greater desirability of young animals as a food source and for thinner hides for clothing. Selective taphonomic removal of juvenile remains can be ruled out at some of these sites, such as Vore, where preservation is excellent.

Some 25 foetal elements were recovered from the block area. While foetal bone is often used to suggest a late winter or spring season for the kill event, such a small sample is of dubious interpretive value. The propensity of a small number of female bison to calve out of season is well documented (McHugh 1958; Reynolds *et al.* 1982), thus casting some doubt on the direct association between foetal bone and seasonality studies (Arthur 1975). Nevertheless, since the vast majority of bison calve in the spring, foetal bone can be taken as a probable indication that the site was at some point used in late winter or early spring. This tells us little about the full scope of seasonal use of the site, however. The small sample of foetal bone does not argue for an important use of the site in the spring. Yet factors of preservation easily could have skewed the importance of this fragile faunal class.

Speth (1983) has suggested another way to view the assemblage of mature and immature animals from a bison kill. This concerns the relative "utility" of different limb bones as measured against Binford's utility indices. The method allows an examination of the intensity of butchering of older versus younger animals, and may indicate preferential selection. Speth used fused versus unfused leg elements, the same criteria we used to distinguish mature from immature animals. Since limb bones dominate the HSI assemblage, it is useful to consider this method.

Table 25 gives the number and percent of the mature and immature limb bones from the HSI processing area. Only essentially complete element portions (MNE) are included in this table, and the percent is based on the total number of identifiable specimens of each element.

Table 25. Number and percent (MNE) of mature and immature limb bones from DkPj-1, 1985/86 excavations, and MGUI value.

	Mature MNE		Immature MNE		
ELEMENT	#	%	#	%	MGUI*
Prox. Humerus	0	0.00	0	0.00	40.375
Distal Humerus	15	6.36	0	0.00	34.655
Proximal Radius/Ulna	44	7.33	2	0.33	25.47
Distal Radius/Ulna	30	5.00	13	2.17	21.145
Proximal Metacarpal	32	19.16	2	1.20	11.145
Distal Metacarpal	36	21.56	6	3.59	9.475
Proximal Femur	1	0.26	1	0.26	90.29
Distal Femur	0	0.00	0	0.00	90.29
Proximal Tibia	2	0.85	0	0.00	58.36
Distal Tibia	59	25.21	15	6.41	42.395
Proximal Metatarsal	30	12.99	1	0.43	22.85
Distal Metatarsal	34	14.72	6	2.60	18.02

* Data from Binford (1978:74, Table 2.7)

Following Speth (1983:93-95), MGUI values from Binford (1978) are assigned to each element, and, since the values for some proximal and distal elements differ, the higher value is consistently selected. Although many who have used Binford's indices, including Speth, have used the data for caribou instead of sheep, the MGUI values presented here are averages of the data for the two different animals contained in Binford (1978:74, Table 2.7). To achieve a % MNE for the mature and immature bones as a whole, the values in Table 25 for each articular end are combined to produce a single value for the element. These data are plotted in Figure 57.

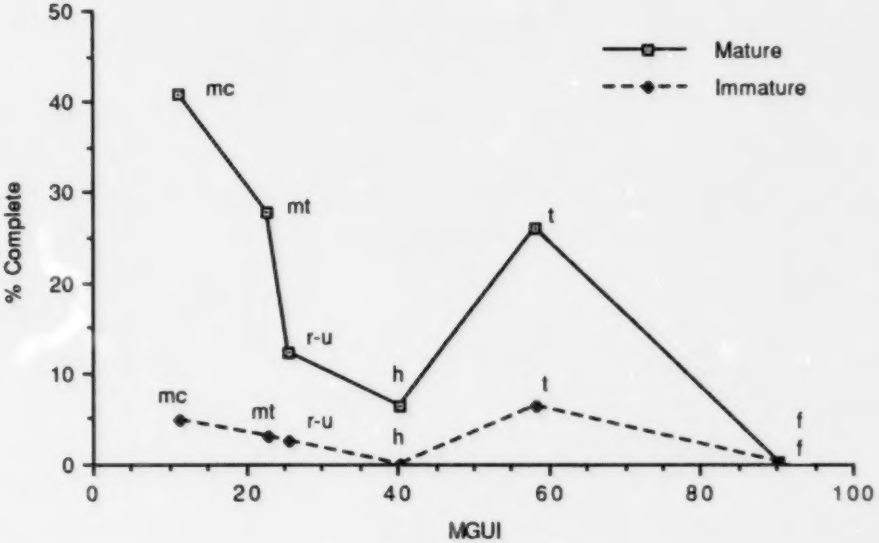


Figure 57. Relationship between % MNE and Binford's (1978) MGUI, for mature and immature limb bones from DkPj-1.

At the Garnsey site, Speth (1983:93) noted that the proportion of complete (MNE) elements abandoned on site tends to increase as one moves down the limb bones, that is, in the direction of lower utility value in Figure 57. This is as predicted by Binford's index. Although the pattern is variable, the same trend appears to be true at HSI; the more proximal elements, of high utility value, are poorly represented, and the lower value distal elements are seen to be increasing in relative proportion. This is true for both the mature and immature animals. An exception is the tibia, which greatly exceeds the predicted frequency. As seen in Table 25, the tibia is represented almost entirely by distal ends. This very dense bone was one of the most commonly recovered elements, and this is attributed, at least in part, to the enhanced survivability of this portion of the element.

Binford's MGUI index ranks the proximal bones of the hind limb - the femur and proximal tibia - higher than the equivalent bones from the front limb. This is a result of his evaluation of the meat, marrow and bone grease properties of these elements. Accordingly, these should more commonly removed or destroyed through processing, and, therefore, they should be less visible at subsequent archaeological sites. This trend was evident at the Garnsey kill site, but it is only partially true at the Head-Smashed-In processing area. While the femur is the least common element, the humerus is considerably more common than the tibia, contrary to the prediction of the MGUI. Again, the frequent of distal tibiae is the source of this discrepancy. If proximal tibiae were plotted separately in Figure 57, the value for this element portion would be less than that for the whole humerus (although still greater than the proximal humerus which, like the distal femur, has an MNE of zero). The metapodials follow the predicted pattern, with the hind element less common than the front.

Speth (1983:95) also shows that all immature limb elements had a greater proportional frequency at Garnsey than did the mature elements. This is clearly the opposite of the HSI situation where, except for tied values for the femur, all mature elements are proportionally more common than the same element from immature animals. Speth's results are at odds with the bulk of information presented above which showed a decided bias against immature animals at northern Plain's kill sites. This bias was documented primarily on the basis of mandibles, however, and may not be as evident in the limb bone samples. At HSI the relative scarcity of immature elements is believed to be partially the result of greater taphonomic destruction of these bones, probably coupled with a reduced rate of identifiability of fragmented immature specimens. In addition, the two curves in Figure 57, since they represent relative frequency for elements in each age group separately, also can be interpreted as suggesting that there was intentional preferential selection of younger animal remains for butchering.

Cut Marks and Green Bone Fractures

The generally eroded nature of the Head-Smashed-In fauna is not conducive for the identification of butchering cut marks and green bone fractures. All elements from the block excavation and the spring channel were examined by Jean Wright for cut marks and fresh fractures. The results are presented in Tables 26 and 27 and Figures 58 and 59.

Cut marks were observed on some 76 specimens. Eight of these were from unit 39 in the spring channel, and the remainder were from the block excavation. As seen in Table 26, almost half (48.68%) of the cut marks were identified on fragmentary remains, and almost one third (31.58%) of all cut marks were found on the unidentified fragments of limb bones. Ribs and rib fragments, mostly body sections, accounted for another 22.37% of all cut marks. Cut marks on appendicular elements outnumbered those on axial elements by about 2 to 1. Some, albeit few, cut marks were found on all of the major limb bones, exclusively on the shaft and distal end portions. Since the retention of cut marks on severely weathered bone is dependent upon suitable preservation, it is not surprising that the majority of specimens which exhibited cut marks were recovered from lower levels of the excavation. While 32.15% of all fauna was recovered from level 1 of the excavation, only 20% of the cut mark specimens were found in this level. In contrast, 80% of all cut marks were from levels 2-5, while 67.85% of all fauna were found in these levels. Thus, relative to the full faunal record, a somewhat higher proportion of cut marks were from the deeper levels. With such a small sample size, no conclusions about cut marks can be considered firm.

Green bone fractures are presumed to occur at the site as a result of the intentional breaking of bones to extract marrow and to render bone grease. Green bone fractures were far more numerous than cut marks, possibly because they are less easily eroded and perhaps because they are a more common by-product of bison butchering. Smashing a single bison bone for marrow or grease extraction could produce dozens of specimens exhibiting evidence of fresh fracture. There is increasing evidence that carnivores are equally capable of producing green bone fractures, thus reducing the confidence of attributing these features to cultural activity (Binford 1981,1984b; Haynes 1983). No doubt carnivores were active at

Table 26. Cut marks, DkPj-1, all 1985/86 excavations.

ELEMENT (CODE#)	#	%
Mandible (4)	1	1.32
midsection	1	1.32
Thoracic vert (9)	4	5.26
vert projection	3	3.95
ver fragment	1	1.32
Rib (13)	9	11.84
head	2	2.63
body	7	9.21
Pelvis (15)	1	1.32
acetabulum	1	1.32
Scapula (16)	1	1.32
glenoid cavity	1	1.32
Humerus (17)	2	2.63
distal end	1	1.32
shaft	1	1.32
Radius (18)	1	1.32
shaft	1	1.32
Ulna (19)	4	5.26
shaft	3	3.95
distal end	1	1.32
Metacarpal (37)	1	1.32
distal end	1	1.32
Femur (27)	5	6.58
shaft	5	6.58
Tibia (29)	6	7.89
distal end	3	3.95
shaft	3	3.95
Calcaneus (32)	1	1.32
Metatarsal (38)	3	3.95
distal end	3	3.95
ELEMENTS NISP	39	51.32
Metapodial (39)	5	6.58
distal end	1	1.32
shaft	4	5.26
Longbone fragment (60)	24	31.58
Rib fragment (70)	8	10.53
FRAGMENT NISP	37	48.68
TOTAL CCUNT	76	100.00
	#	%
AXIAL ELEMENTS	23	30.26
APPENDICULAR ELEM.	53	69.74

Head-Smashed-In and produced some of the fractures we have observed. Since direct evidence of carnivore activity (e.g., gnaw marks or puncture holes) was nearly non-existent, it is impossible to separate the agents responsible for the observed fractures. The following summary is presented in the belief that most of the fresh fractures were likely the result of the human activities associated with processing of bison carcasses.

Table 27. Green bone fractures, DkPj-1, all 1985/96 excavations.

ELEMENT (CODE No.)	#	%
Mandible (4)	3	0.23
midsection	2	0.15
distal	1	0.08
Thoracic vert (9)	2	0.15
vert projection	2	0.15
Rib (13)	8	0.62
head	5	0.39
body	3	0.23
Pelvis (15)	8	0.62
ilium	1	0.08
acetabulum	7	0.54
Scapula (16)	8	0.62
glenoid cavity	5	0.39
anterior border	2	0.15
blade	1	0.08
Humerus (17)	106	8.19
proximal end	4	0.31
distal end	40	3.09
shaft	61	4.71
n/a	1	0.08
Radius (18)	132	10.20
proximal end	72	5.56
distal end	24	1.85
shaft	33	2.55
n/a	3	0.23
Ulna (19)	23	1.78
proximal end	10	0.77
shaft	9	0.70
distal end	4	0.31
Lunate (21)	1	0.08
Cuneiform (22)	1	0.08
Metacarpal (37)	108	8.35
complete	2	0.15
proximal end	51	3.94
distal end	49	3.79
shaft	5	0.39
n/a	1	0.08
Femur (27)	88	6.80
complete	1	0.08
proximal end	5	0.39
shaft	81	6.26
n/a	1	0.08
Tibia (29)	256	19.78
proximal end	7	0.54
distal end	80	6.18
shaft	163	12.60
n/a	6	0.46
Lateral malleolus (30)	1	0.08
Cuniform pes (34)	6	0.46
Metatarsal (38)	103	7.96
proximal end	50	3.86
distal end	48	3.71
shaft	3	0.23
n/a	2	0.15
1st phalanx (40)	4	0.31
2nd phalanx (41)	1	0.08
ELEMENTS NISP	859	66.38

FRAGMENTS	#	%
Metapodial (39)	63	4.87
proximal end	6	0.46
distal end	16	1.24
shaft	39	3.01
n/a	2	0.15
Longbone fragment (60)	361	27.90
Costal cart. (63)	2	0.15
Skull fragment	2	0.15
Rib fragment (70)	4	0.31
Vert fragment (71&72)	2	0.15
Indeterminate (99)	1	0.08
FRAGMENT NISP	435	33.62
TOTAL COUNT	1294	100.00

	#	%
AXIAL ELEMENTS	31	2.40
APPENDICULAR ELEM.	1261	97.60

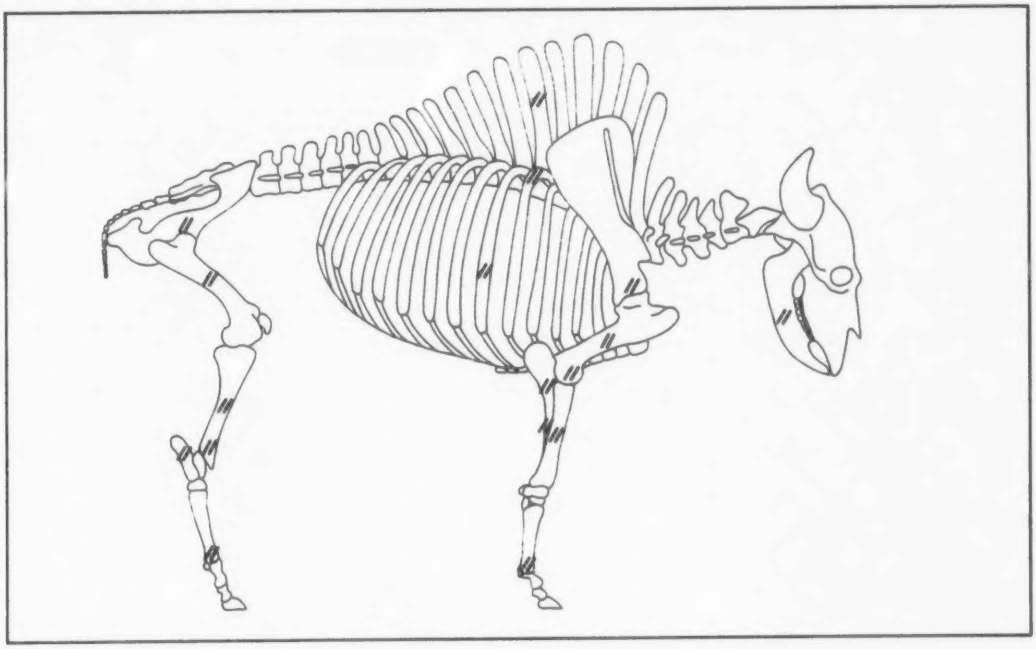


Figure 58. Location of butchering marks observed on bison bone, DkPj-1.

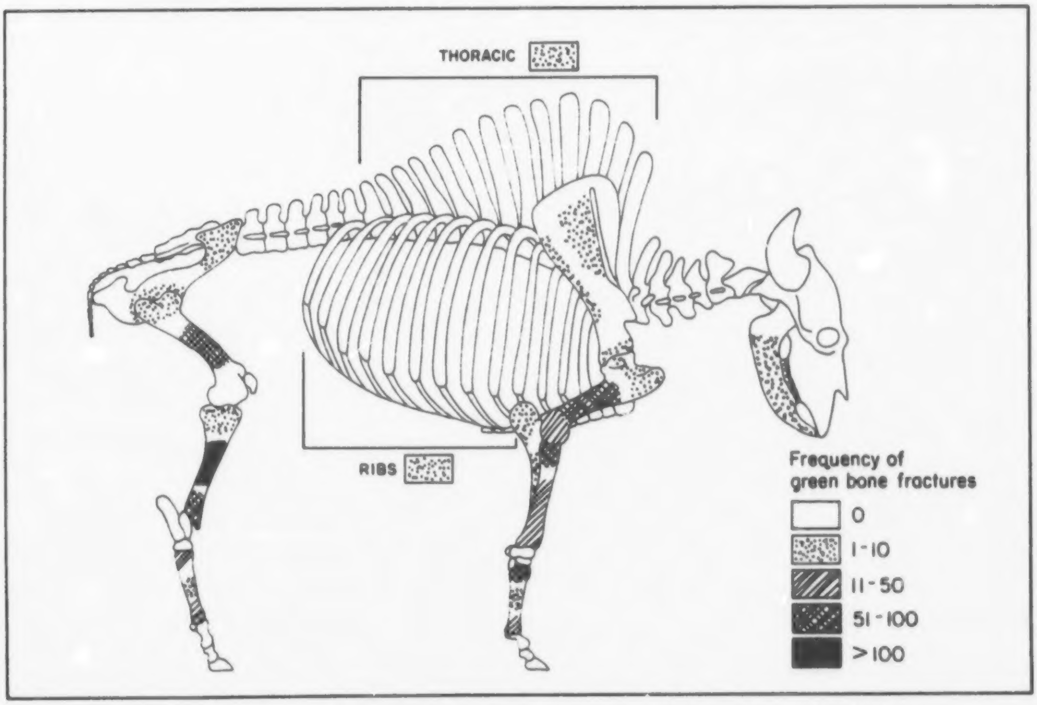


Figure 59. Frequency of green bone fractures on bison bone, DkPj-1.

In total, 1,294 individual specimens were observed to have evidence of sharp-edged, spiral fractures suggestive of human modification. The vast majority (97.6%) were located on appendicular elements. Again, long bone fragments, primarily shaft portions, accounted for the largest part of the sample (27.9%). The tibia was the best represented single element, containing 19.78% of all observed fractures, mostly on the shaft portion. In large part, this probably reflects the high incidence of identification of tibia shaft portions (due to the distinguishing muscle attachment ridges) as opposed to other limb bone shafts. The humerus, radius, metacarpal, femur and metatarsal also account for a large portion of all identified fractures. No single axial element contributed even 1% of the sample.

It is interesting to note that, despite the enhanced preservation of the fauna from the spring channel, examination of the 537 specimens from this location revealed evidence of only 14 fresh fractures. Since this assemblage has been deposited directly from the kill site and has not been subjected to the processing activities of the prairie level fauna, these results suggest that minimal intentional breakage of bones occurred at the kill. As has already been noted, many of the elements from this location were complete, and many were from the axial skeleton. Given what is known of bison processing, which favoured marrow and grease rendering from the limb bones, and the clear dominance of fresh fractures on the appendicular elements from the block excavation, the paucity of fresh fractures on the axial material from the spring channel is not surprising.

While our examination of elements for green bone fractures focussed on larger, identifiable specimens, this is not the only available data for documenting the practice of bone breakage and reduction. Recently, we have learned of attempts to identify the activity of smashing fresh bones, possibly in association with grease rendering, through the microscopic examination of tiny bone fragments recovered during fine screening (R. Morlan, personal communication 1988). Working with extremely well preserved bison material from Saskatchewan, Morlan has focussed on the identification of specimens which retain evidence that the minute fragments were smashed while the bones were still fresh. The presence of an abundance of such fragments could provide evidence for the intentional reduction of large mammal bones to a size suitable for grease rendering. For comparative purposes, we sent Morlan samples of tiny bone fragments recovered during the fine screening of soil matrix from the processing area excavation at Head-Smashed-In. Vials of bone fragments in the following size categories were examined: >3.35 mm, >1.40 mm and >0.850 mm. Morlan reports that, while a few of the Head-Smashed-In specimens exhibited the fracture features associated with green bone breakage, the vast majority exhibit eroded surfaces more characteristic of taphonomic reduction (personal communication 1988). Morlan singles out weathering and trampling of already dry bones as the agents most likely responsible for the observed breakage patterns.

In summary, the examination of the larger fauna strongly suggest the fresh fracturing of bison leg bones during butchering and processing. In contrast, very little evidence of this activity was found on the specimens from the kill site material recovered in the spring channel. It is recognized, however, that non-cultural processes, especially carnivore gnawing, could also have produced the observed patterns.

Intra and Inter Site Comparisons

In this section, the fauna from different parts of the 1985/86 excavations at HSI will be compared, including the block excavation, the spring channel and the HSI kill site. Comparisons also will be made between these faunal assemblages and assemblages from other bison kill sites on the northern Plains. These external comparisons are not exhaustive, being limited partly by inadequate data presentation in the published reports, and are presented here as an indication of similarities and differences between different sites, not as a comprehensive review. In order to avoid lengthy tables of fauna from other sites and long, descriptive counts, graphic plots of representative elements from the bison carcass, similar to those already presented, are the primary means of site comparison. The unit of comparison in all cases is NISP, as this is often the only measure of quantification available in other reports.

Internal Comparisons

In order to compare our data from the block excavation on the prairie and from the spring channel with that of the HSI kill site, some explanation is in order concerning the origin of the kill data. Although a detailed faunal report for the kill site has not been published, a manuscript report was produced which listed the total count of elements for each of the five cultural periods identified by Reeves: Mummy Cave, Pelican Lake, Besant to Pelican Lake, Avonlea and Old Women's (Lifeways of Canada 1980). This report identifies the fauna according to a system of classification for bison remains developed by John Brumley and subsequently modified and expanded by Reeves.

Many more categories of bone units were recognized in this analysis than have been employed by us at Head-Smashed-In. For example, we identify a humerus in four categories (complete, proximal, distal and shaft); the Lifeways report has 41 units of classification for the same bone. For comparisons to be made, it was necessary to convert one set of fauna. This was done to the kill site data using the descriptions of the individual butchering units supplied to us by Brumley and by T. Smith of Calgary. Time does not permit re-cataloguing the enormous collection of kill site fauna; instead, the conversion was done on paper using the counts of each bone unit for each cultural period provided in the Lifeways manuscript. In other words, using the written descriptions of the bone element and the tables of kill fauna in the Lifeway's report, we converted the fragments of humeri into our grosser categories of complete, proximal, distal or shaft. Without looking at each bone, it is entirely possible that some mistakes were made in assigning the Lifeways categories to one of our units of bison bones; however, it is much simpler to convert the complex Lifeways data into the general classes of our system than to attempt the reverse. Overall, we believe that the figures we obtained should provide accurate NISP counts for the kill site.

No attempt was made to calculate MNE or MAU for the kill assemblage, since this would obviously require a re-examination of all the original data. NISP was totalled for each of the five cultural units identified by Reeves, as this is how the data are presented in the Lifeways report. In addition, we combined into groups the data for the Middle Prehistoric assemblages (Mummy Cave+Pelican Lake+Besant to Pelican Lake), and for the Late prehistoric assemblages (Avonlea+Old Women's), and for the entire kill assemblage.

Before making comparisons with the kill site data, it is worth examining these latter data independently. Our conversion of the HSI kill data into comparable units of classification shows extremely little difference in the entire kill assemblage over the past 5,700 years. Figure 60 compares the % NISP for sixteen skeletal elements from the combined levels of the Late and Middle Prehistoric periods at the HSI kill.

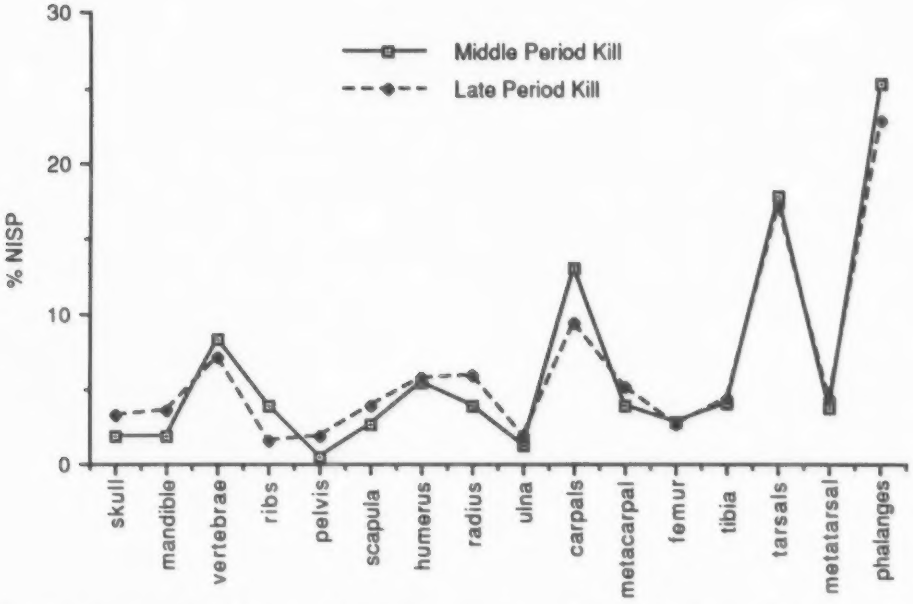


Figure 60. Comparison of Middle and Late Prehistoric faunal assemblages from the kill site, DkPj-1. (Data are adapted from Lifeways of Canada [1980].)

It can be seen that there are no major variations in the proportion of element frequency during the earlier and later use of the kill. This observation is not the result of having combined separate cultural occupations of the site, as defined by Reeves (1978), into two gross periods. To illustrate, Figure 61 compares just the assemblages from the earliest use of the jump, the Mummy Cave material, with the latest use, the Old Women's material. If anything, the similarity between the assemblages is even stronger than when the two time periods were compared. Most of the 16 elements occur in almost equal proportions despite the nearly 5,000 year time difference.

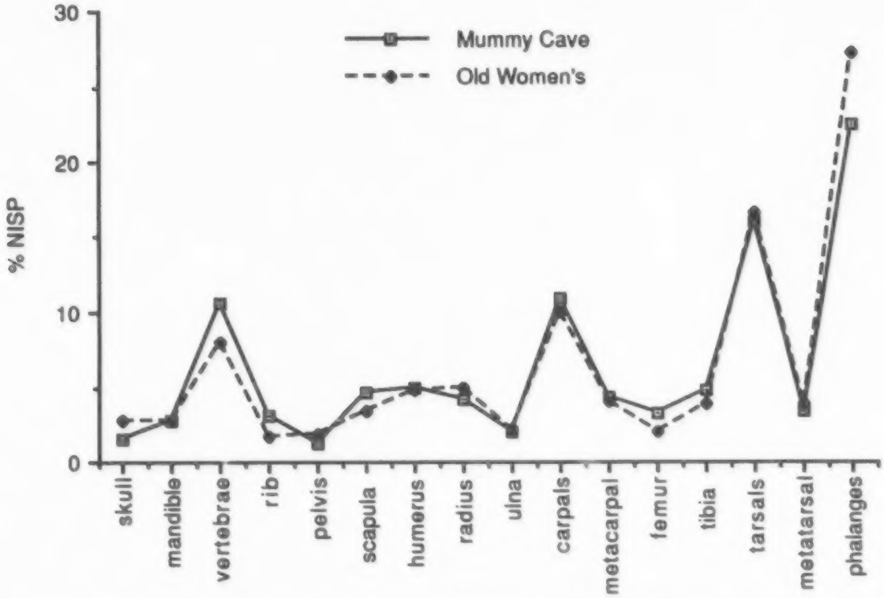


Figure 61. Comparison of Mummy Cave and Old Women's faunal assemblages from the kill site, DkPj-1. (Data are adapted from Lifeways of Canada [1980].)

The similarity of assemblages through time is somewhat surprising. Frison (1982) has noted the considerable difference between the treatment of bison bones at Early versus Late Prehistoric kill sites. We would have expected a greater degree of difference between the treatment of fauna at HSI during Middle and Late Prehistoric times. It must be remembered that it cannot be assumed automatically that the kill assemblages accurately reflect the state of the fauna as discarded after the kills. While preservation of the kill site fauna is demonstrably better than that of the prairie (Reeves 1978), other agents may have transformed the different temporal assemblages into homogeneous units. It is also possible that our conversion of the kill fauna into our classification units has tended to obscure variation which may be present in the kill material. These possibilities notwithstanding, it appears that the HSI kill assemblage is characterized by an extremely high degree of similarity through time. Only further research will confirm or refute this suggestion.

Turning to intra-site comparisons, given that the faunal material recovered from the spring channel undoubtedly originated from the kill deposits located directly upslope, it can be expected that the former assemblage would mimic that recovered from the kill site excavations conducted by Reeves (1978). Figure 62 presents a comparison of the fauna recovered from the spring channel excavations with that for the kill site assemblage. This graph employs the generalized groupings of 16 elements thought to be reflective of the assemblage as a whole. Further detail of the axial skeleton is provided in Figure 63, where these elements are identified more specifically. Figure 64 likewise gives greater detail of the relationship between the limb bone component of the two assemblages. In this last figure, the proximal scapula refers to the glenoid articular surface, and the distal scapula refers to the remainder of the blade. Since the material recovered from the spring channel was clearly a jumbled mixture of fauna and projectile points from all time periods, Figures 62 to 64 use for comparison data from the entire kill assemblage.

Perhaps the most interesting observation from Figures 62 to 64 is the dissimilarity between the two respective faunas. As was noted in comparing the spring channel with the processing area, there is again a dichotomy between the representation of axial and appendicular elements. The spring channel, having derived from upslope kill deposits, was expected to mimic the kill assemblage, but it does not. Skull material is much more frequent in the channel than at the kill, as are mandibles, most of the vertebrae, ribs and pelvis. The skull difference perhaps can be explained as a factor of preservation, in that skulls which remained in the valley of the spring may have been more likely to be buried quickly by fluvial and colluvial deposits. Skulls hauled onto the benches at the base of the kill would not have been buried as rapidly and would have been exposed for a longer time to various destructive agents. Alternatively, skulls may have been transported from the main kill but not from the less accessible region of the channel. The differences in other axial elements are not explained so easily. While all elements probably would have benefitted from burial in the channel, some, such as cervical vertebrae, would be expected to be abandoned at the kill and to have preserved fairly well. Given our current concepts of kill/butchery bone beds, the general paucity of axial material at the Head-Smashed-In kill site is surprising.

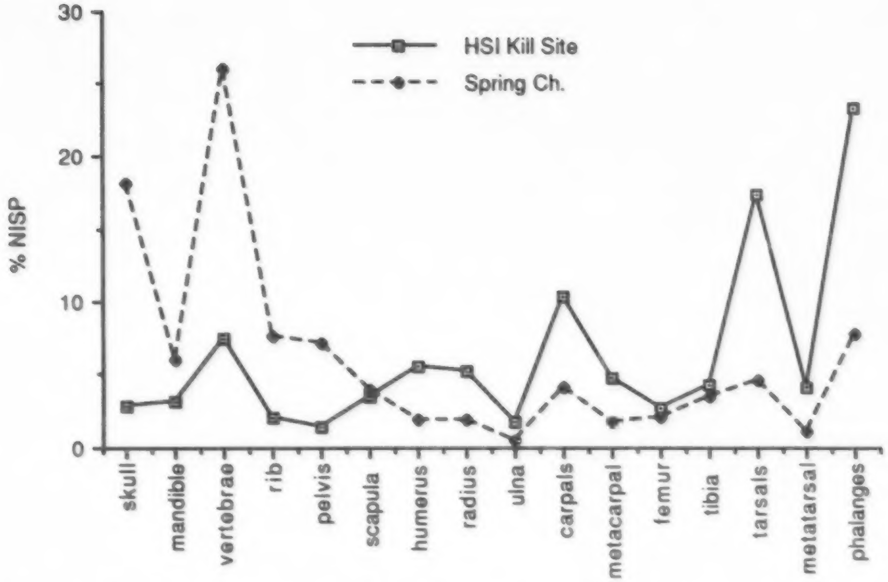


Figure 62. Comparison of % NISP for the kill site and spring channel fauna, DkPj-1. (Data for kill site are adapted from Lifeways of Canada [1980].)

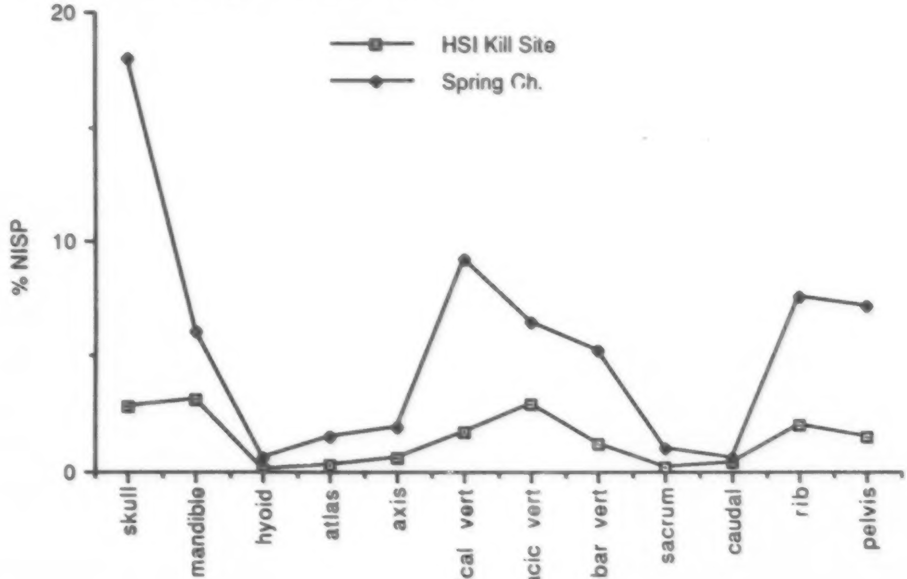


Figure 63. Comparison of % NISP of axial elements from the kill site and the spring channel, DkPj-1. (Data for kill site fauna are adapted from Lifeways of Canada [1980].)

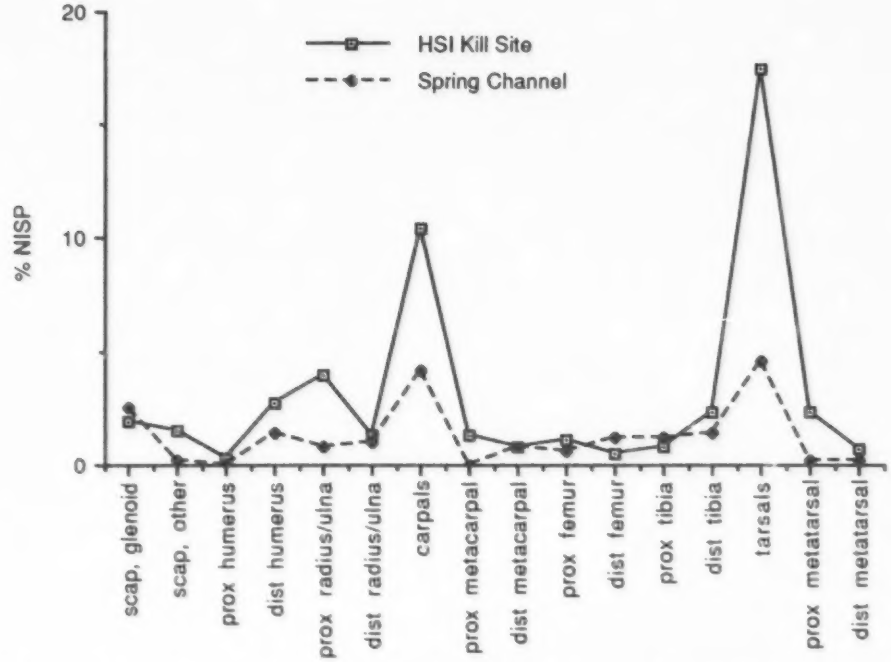


Figure 64. Comparison of % NISP of limb bone elements from the kill site and the spring channel, DkPj-1. (Data for kill site fauna are adapted from Lifeways of Canada [1980].)

Differences between the appendicular elements are not as striking. The kill deposits have a much higher percent of carpals, tarsals and phalanges, and slightly higher values for the distal humerus and proximal radius. Otherwise, the limb bones from the two areas form approximately similar percentages of the entire samples. It should be emphasized that the testing of the spring channel was not viewed as a subsample of the kill site, that the numbers of elements are relatively low, and that divergences from the kill faunal population may well be a sampling error. Furthermore, because the bones were recovered from the head of a spring channel, it is possible that fluvial processes have selectively removed certain elements. The remaining sample may be more indicative of those elements which resist fluvial transport than they are a true subsample of the original kill population. Historical information about the spring suggests, however, that the spring is more of a seep, seldom flowing with any velocity. For the moment, the role of the spring in transporting bones is unknown, as is an explanation for why the channel deposits are not an accurate mirror of the kill sample.

Next, the faunal remains from the block excavation area are compared to the kill site deposits. Here, we would expect the two samples to show marked differences arising from selective and patterned abandonment of certain elements at the kill and transport of other elements to the processing area on the prairie below. Again our expectation is not supported by the data. Figure 65 shows the relative percent of general skeletal elements from these two areas. In this figure, we have used only the data from the Late Prehistoric Period use of the kill site (Avonlea and Old Women's). This is because virtually all the data recovered from the processing date to this time period, and it seems appropriate to compare similar temporal periods in so far as possible. The kill site is seen to have very slightly higher proportions of skull, mandible and vertebrae material, but otherwise the assemblages are strikingly similar.

Because limb bones make up a large percentage of the processing area assemblage (possibly an indication that they were highly selected for from the kill assemblage), it is worth comparing the relative percentages of these elements from the two assemblages. Figure 66 plots the relative percentage of limb bones. While it would be expected that limb bones, if indeed they were selected for preferentially transport to the prairie, would form a much smaller percentage of the kill assemblage; such is not the case. The relative percent of each limb element is nearly identical from the two areas.

How is this reversal of the expected pattern to be explained? Again, factors mentioned above concerning taphonomic homogenization and potential problems with our re-coding of the kill site fauna can be invoked; however, another alternative can be raised. It is known that many of the bone layers at the kill site were characterized by severe burning (Reeves 1978). This is common to other jumps in the area, including the Old Women's Jump (Forbis 1960) and the Calderwood Jump (Brink *et al.* 1987; Marshall and Brink 1986). Perhaps, when a layer of bone from a recent kill event is burned, certain elements are more likely than others to survive the burn event. This might be especially true of the the articular ends of certain leg bones, those with the densest bone mass and, hence, the lowest content of flammable bone grease. From Figure 66, it can be seen that the kill assemblage mirrors that of the processing area in that the most common bones are those which, based on Lyman's (1982) research with

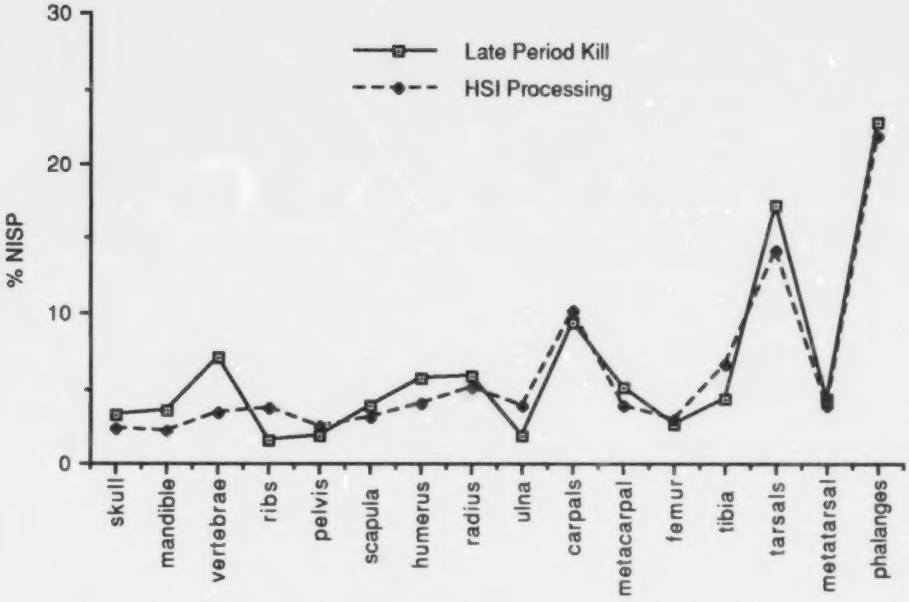


Figure 65. Comparison of % NISP of general skeletal elements from the kill site and the processing area, DkPj-1. (Data for kill site fauna adapted from Lifeways of Canada [1980].)

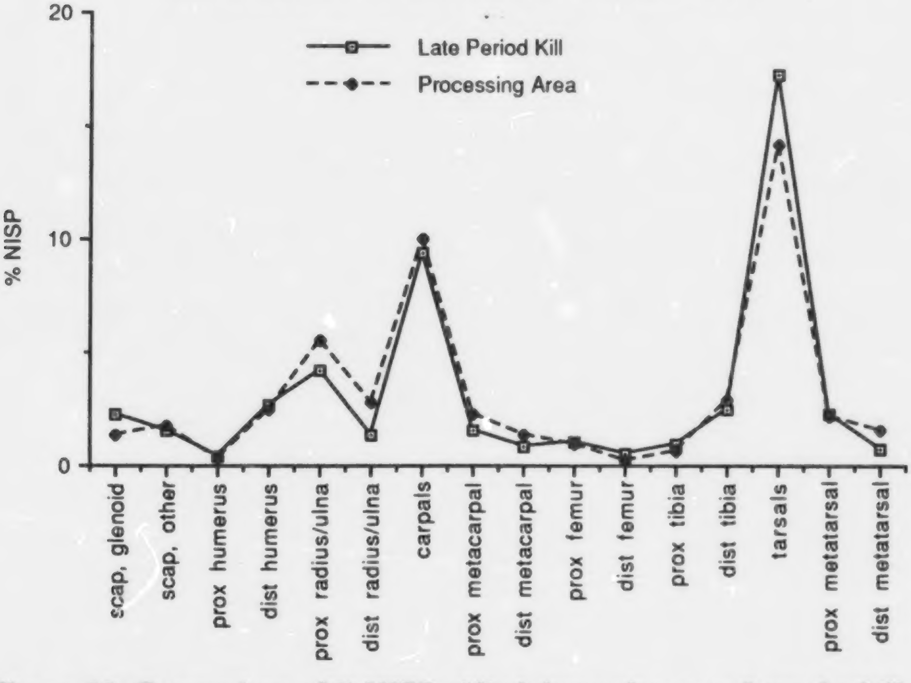


Figure 66. Comparison of % NISP of limb bone elements from the kill site and the processing area, DkPj-1. (Data for kill site fauna are adapted from Lifeways of Canada [1980].)

deer skeletal material, are the most dense. To examine this possible explanation further would require a re-examination of the kill sample for evidence of selective burning, a task beyond the scope of our current research. It may be worth noting, however, that virtually none of the fauna recovered from the spring channel showed signs of burning. Apparently, fauna entered the channel before the fires started or was protected from fire due to the moisture in the sediments. This may account for the striking differences between the channel and kill site fauna, two assemblages which, in theory, should be very similar.

External Comparisons

It may be instructive to compare briefly the HSI faunal assemblages to those from other Plains bison kill sites. Unfortunately, comparing data from processing areas is made difficult by the paucity of excavations at these kinds of sites. When butchering or processing sites are located immediately next to the relevant kills, it is almost always the latter which receives archaeological attention. Further, when associated butchering areas are excavated, or at least tested, the results are not always presented in a form amenable to comparison. Such is the case with the Big Goose Creek site in Wyoming (Frison *et al.* 1978), one of the most important of the excavated processing areas. Unfortunately, the faunal remains recovered from the processing area at this site are not identified separately. Thus, it is not possible to compare our results to those from Big Goose Creek. Another site with both excavated kill and butchering area components is the Wardell bison trap in Wyoming (Frison 1973). In this case, separate bone counts for the processing area are presented. Figure 67 plots the relative % NISP for samples from the Wardell and HSI processing areas.

Although some variation is apparent, Wardell and HSI appear fairly similar in the relative frequency of elements. Axial elements are scarce in the HSI processing area and even more rare in the Wardell assemblage. From the appendicular skeleton, the major difference is the greater importance of the more distal elements at Wardell. Metapodials, tarsals and phalanges are all relatively more important at Wardell than at HSI. No carpal bones are reported at Wardell, but it is possible that they were ignored in the recovery or catalogue process. It is difficult to believe that none of these bones was present at the site. The importance of the more

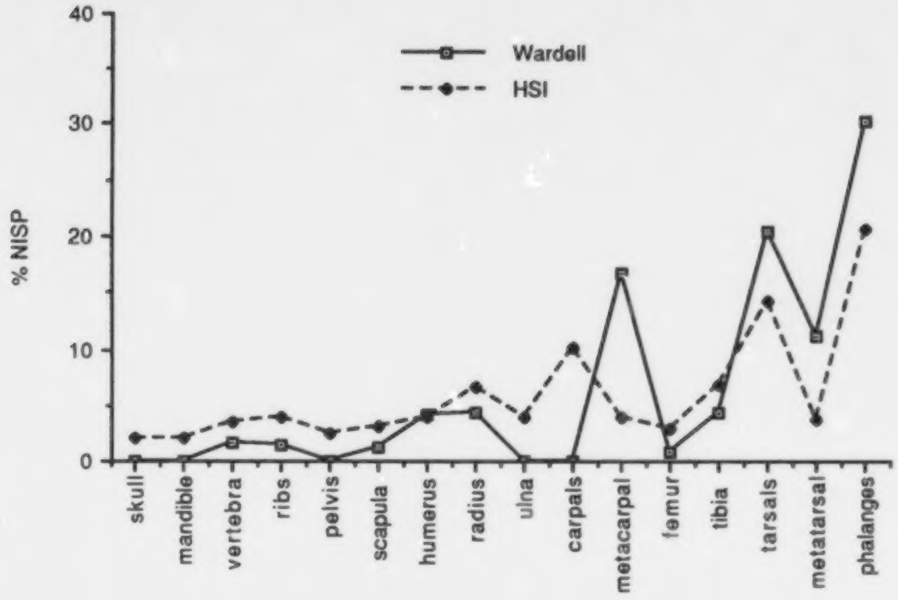


Figure 67. Comparison of general skeletal elements from the Wardell site and DkPj-1 processing areas. (Wardell data are from Frison [1973].)

proximal leg bones is similar at the two sites. Although it is not completely clear from the text, it appears that many of the elements listed for the Wardell butchering area fauna are complete elements or element portions (Frison 1973). If this is the case, it certainly contrasts with the record from HSI where almost nothing was complete.

The Wardell site also had a kill assemblage, and Figure 68 compares the relative percent of elements from this site with that from the HSI Late Prehistoric kill site assemblage. (The Wardell site also dates to the Late Prehistoric Period.) Major differences between the two assemblages are apparent. Wardell tends to have much higher percentages of axial elements, especially vertebrae and ribs, and lower percentages in every limb bone category. In short, Wardell tends to conform to the expected pattern of a kill site faunal assemblage, while HSI seems aberrant in relative paucity of axial material and the corresponding frequency of limb bone elements.

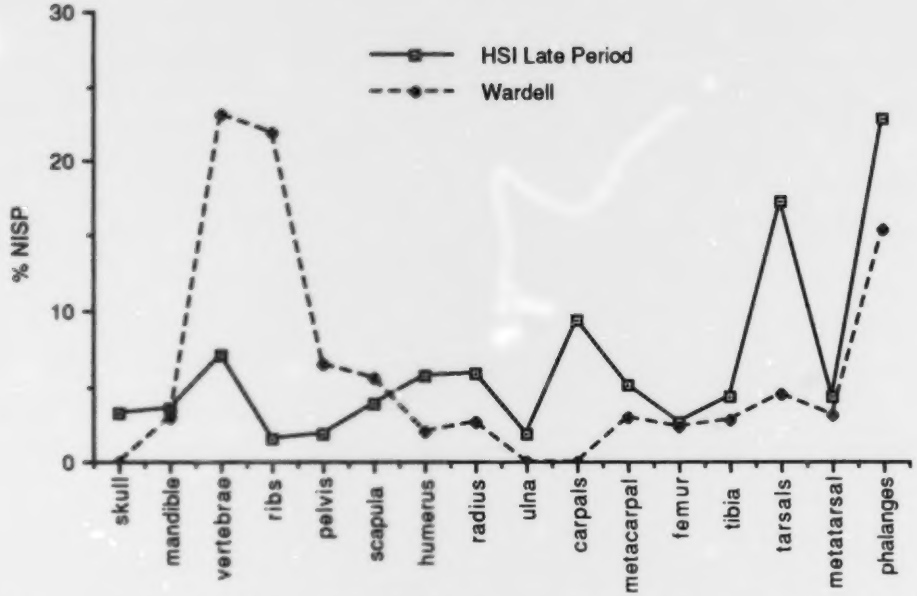


Figure 68. Comparison of the kill site assemblages from the Wardell site and DkPj-1. (Data for Wardell from Frison (1973) and for HSI kill site are adapted from Lifeways of Canada [1980].)

A similar trend is seen when the HSI kill site, late component, is compared with the Glenrock Buffalo Jump (Figure 69). Data from Glenrock, another Late Prehistoric kill site reported by Frison (1970), show the same discrepancy noted above between axial and appendicular elements when compared with the HSI assemblage. Yet, when the spring channel material recovered from HSI in 1985 is compared to the Glenrock kill material (Figure 70) there is considerable agreement between the faunal curves. In other words, the HSI spring channel assemblage resembles the kill assemblages of the Wyoming sites, but not of the site from which this material originated. Perhaps, as suggested above, the firing of the kill deposits, but not those in the spring channel, accounts for this seemingly peculiar pattern.

Thus, there are a number of interesting and unresolved issues concerning the characteristics of kill and processing area faunal

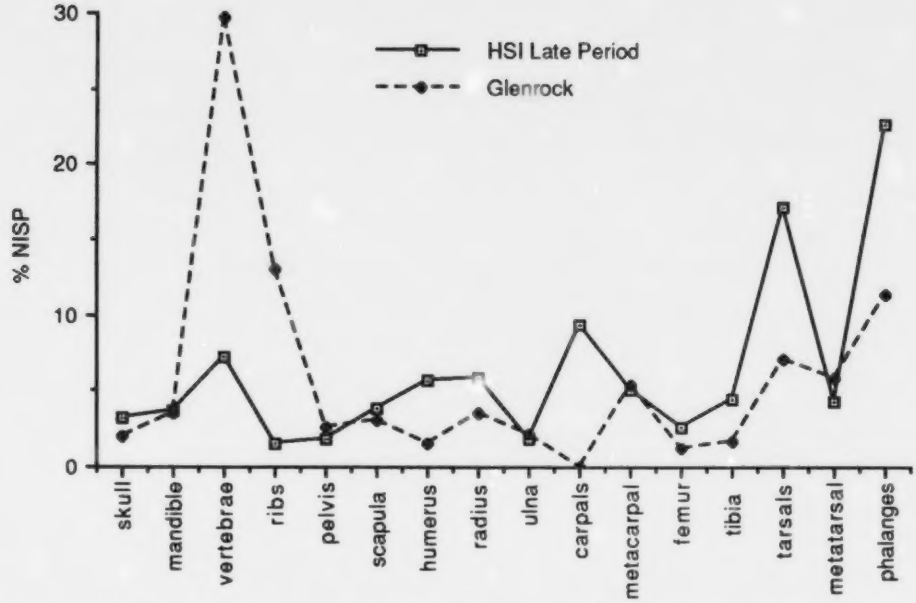


Figure 69. Comparison of the kill site assemblages from the Glenrock site and DkPj-1. (Data for Glenrock are from Frison [1970], and data for HSI kill site are adapted from Lifeways of Canada [1980].)

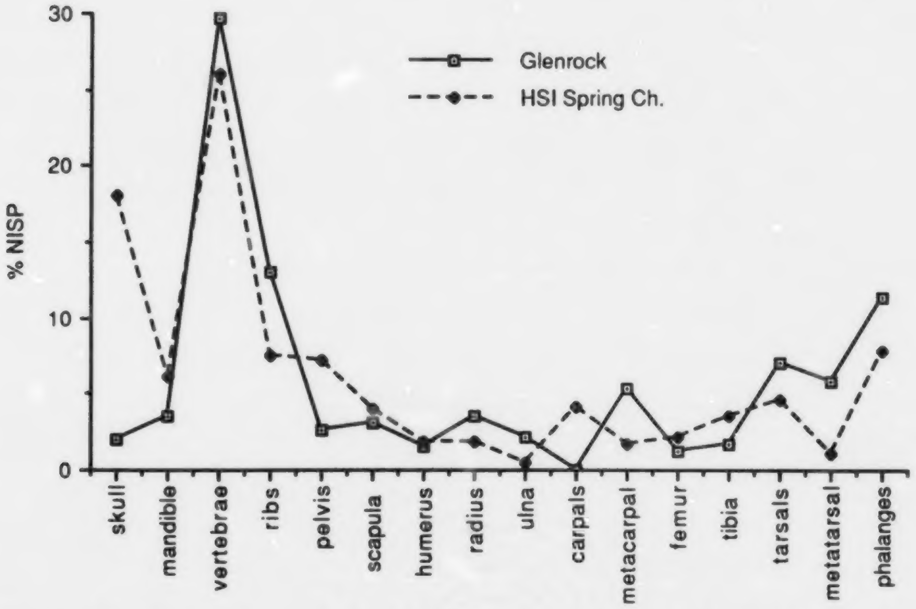


Figure 70. Comparison of the kill site assemblage from the Glenrock site and the spring channel assemblage from DkPj-1. (Data for Glenrock are from Frison [1970].)

assemblages. While lumping faunal elements into the categories used in the graphs presented here is admittedly crude, there is probably some truth revealed by these figures. Other Plains bison kill sites, where both kill and processing areas have been excavated, seem to exhibit striking differences between the two assemblages.

Figure 71 compares the faunal assemblages from the Wardell camp and kill sites. The pattern revealed is as one would expect, based on long standing assumptions of differential faunal partitioning at bison kill and processing sites. Axial elements tend to dominate the kill assemblage, while appendicular are predominant in the camp site area. Wardell may not be representative, however, in that the camp area may not be as closely related to the kill as is the situation at HSI. The Wardell camp is believed to have been occupied over a longer period of time, during different seasons (see Frison 1973), and may represent more of a true camp site rather than a site devoted specifically to bison butchering and processing. Clearly, what is needed are more excavations of both kill and associated butchering/processing area sites, and these need to present separate records of the faunal material. Fuller understanding of the variable patterns apparent today will have to await the availability of these additional data.

Before concluding, it is worth noting that, although the HSI assemblages, especially that from the kill site, seem to contrast markedly with other bison kills, this is not always the case. Figure 72 compares the % NISP from the Gull Lake bison kill site in Saskatchewan with that of the HSI late assemblage.

Considerably greater similarity is evident between these two assemblages than was the case in previous site comparisons. Except for the mandible, Gull Lake and the HSI kill site have nearly identical percentages of axial elements. Further, with the exception of the phalanges, the leg bones are represented nearly equally at both sites. The reason these sites seem to share a more common faunal record is unknown, but again it highlights the fact that considerable variability exists between bison kill sites on the northern Plains.

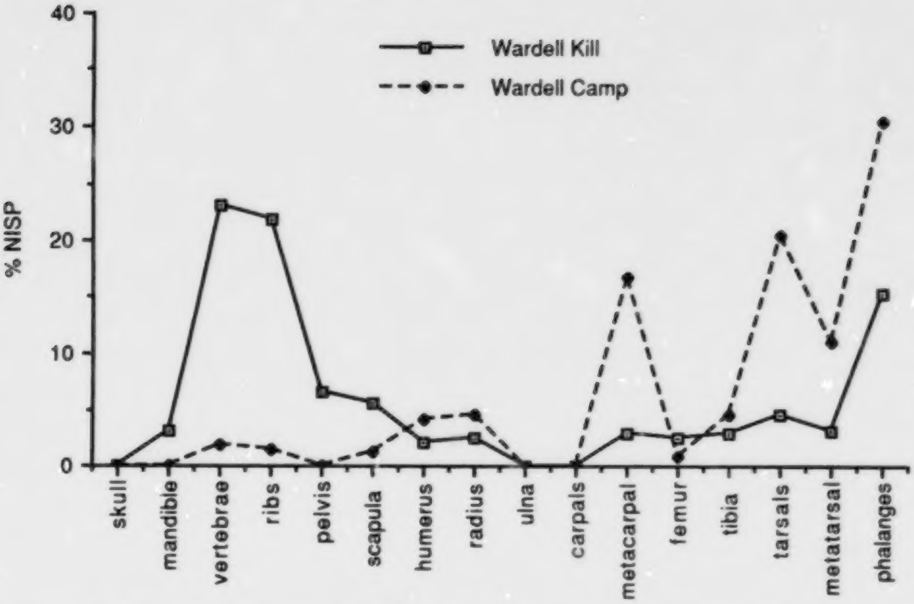


Figure 71. Comparison of % NISP for the Wardell camp and kill sites. (Data are from Frison [1973].)

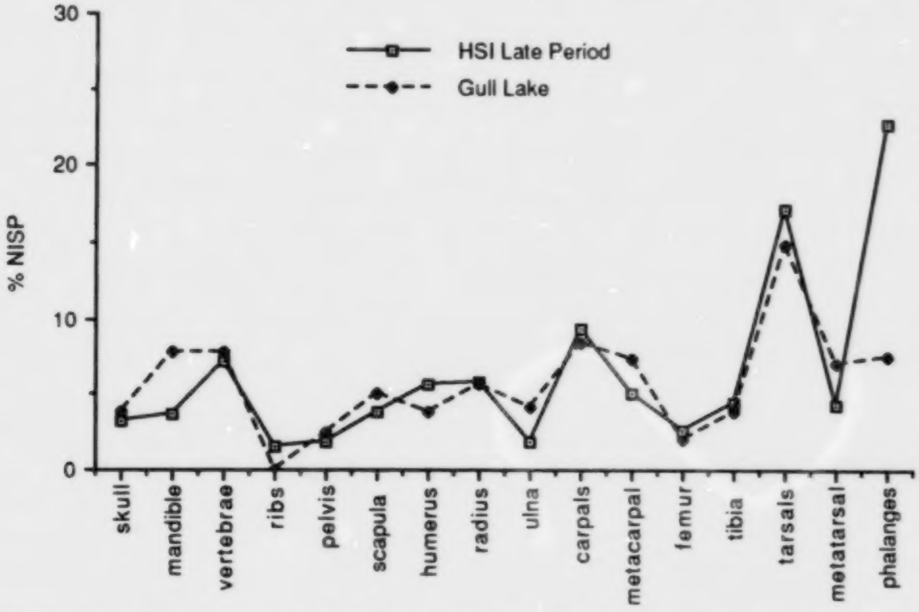


Figure 72. Comparison of the kill site assemblage from the Gull Lake site and the Late Prehistoric material from the kill site, DkPj-1. (Data for Gull Lake are from Kehoe [1973].)

Summary

The Head-Smashed-In processing area faunal assemblage is in a poor state of preservation. As such, it is often difficult to identify with confidence the various causal agents which may have produced the extant assemblage. Direct evidence of faunal modifiers, be they natural or cultural, is often not preserved on the specimens. While it is tempting to suggest that the bulk of the processes which have produced the record visible today were of cultural origin, this cannot be demonstrated with certainty. The context of the fauna - that is, its location on the prairie known to be the centre of bison processing activities - argues for an important component of human selection and alteration of the bone. Yet the very slow burial of this material provided ample opportunity for both scavengers and erosional forces to modify the assemblage. It has been noted that these non-cultural modifiers likely would produce an assemblage that mimics one produced by human action. Hopefully, further research will elucidate the taphonomic processes which have operated on the fauna.

The processing area assemblage is characterized by an abundance of limb bone elements. Axial material is scarce. Of the appendicular elements, the carpals, tarsals and phalanges are best represented. Certain articular ends of major leg bones are also common, especially those believed to be most dense and, hence, most likely to survive. These include the distal tibia, distal humerus, proximal radius and ulna, and both articular ends of the metapodials. Relatively complete portions of leg bone shafts are practically non-existent.

Separate examination of the fauna recovered from both the features and from the stratified portion of the block excavation failed to reveal any substantial differences between these assemblages and that from the general processing area. It would appear that a relatively homogeneous scatter of bison material is to be found all across the processing area, regardless of the specific site context. This could well change if, for example, a feature which clearly had not been reused was encountered.

One conclusion of this research is that there is very little evidence for any change in the selection and preferential processing of bison elements through time at the HSI processing area. We are first to admit, however, that the sample is less than desired for this type of conclusion. Although the stratigraphy evident in the area of the 1985/86 excavations does afford some degree of temporal control, the degree of time resolution in some 50 cm of soil which spans about 2,000 years of time is indeed limited. It would be unwise to say much more than that our methods of examining the data have failed to yield any clear evidence of changes in faunal composition.

Although small in scope, the test excavations of the spring channel that flows from the kill area produced an interesting assemblage which differed considerably from that of the processing area. Axial material was well represented in the channel, and appendicular elements were of correspondingly lesser importance. Bone preservation was noticeably improved. The nature of the assemblage was, in short, typical of what we have come to expect from a bison kill site. When the spring channel material was compared to the % NISP from other excavated bison kills in the northern Plains, considerable similarity was noted.

Sexing of three skeletal elements indicated that the majority of animals butchered at the processing area were females. This is in keeping with the results at most other bison kill sites. Unfortunately, too few elements from the spring channel fauna were sexed to provide a reliable indication of the composition of this assemblage. The few bones which were sexed, however, did suggest a more even sex ratio in the channel deposits. This may indicate that females were selected preferentially from the kill to be brought to the processing area.

Age data for the fauna is largely inconclusive because much of the fragmented material cannot be assigned an age class. Mature animals dominate the identified specimens, but this simply may reflect the better preservation of the bones of older animals. Similarly, no good data on the season of site use were recovered. That some foetal bone was recovered indicates that at least some use of the site in the late winter or early spring. The dominance of females in the analysed bones can be interpreted tenuously as suggesting some fall use of the site; however, no definite conclusions are possible at this time.

An economic analysis of the processing area fauna suggests that it is possible to interpret the recovered materials as indicating an efficient use of the bison carcass in a way which maximized the nutritional value of various carcass parts. In other words, the relative frequency and the presence and absence of skeletal elements, for the most part, conforms to the predictions of indices which model animal food utility. It was found that indices based upon limited data for bison seemed to predict these faunal patterns better that the indices devised by Binford (1978) and based on other anatomical data for other animals. It was noted again, however, that taphonomic processes could be equally responsible for generating the faunal patterns observed at the site today. Human efficiency in faunal utilization, while attractive as an explanation, is unproven at this point.

Finally, the fauna recovered from the 1985/86 excavations has been compared to that from a small selection of other Plains kill sites. The fauna from the HSI processing area resembles that recovered from the Wardell camp site, suggesting that there may be patterned remains of bison processing in parts of the northern Plains. On the other hand, there is some doubt that the Wardell camp site can be equated to a true processing site. The spring channel material from HSI was seen to compare favourably to the fauna from several other Plains kill sites, as would be expected given that the channel material originated from the HSI kill.

Other comparisons were made between the HSI kill site faunal material. Data for these comparisons were adapted from a report by Lifeways of Canada (1980) which presented tabulations of all elements and element portions recovered from the kill site excavations conducted by Reeves (1978). Comparison of Middle and Late Prehistoric cultural layers within the kill deposits indicated a near absence of evidence of the faunal assemblages changing through time. This homogeneity may be due to taphonomic alteration (including fire) of what were once differing assemblages or to errors in our attempts to summarize the kill fauna, or it may reflect the true character of an internally consistent pattern of butchering bison over the past 5,700 years at HSI.

Interestingly, our comparison of faunal material from the HSI kill, as abstracted from the Lifeways of Canada report, and other bison kill sites showed striking differences. The HSI kill material was more similar to a processing assemblage, composed of a high percentage of broken appendicular elements. It was also noted, however, that the HSI kill assemblage was fairly similar to another western Canadian bison kill, the Gull Lake site. It is also recognized that the method of comparison used here, graphic plots of the % NISP for a selection of skeletal elements, may be too crude a measure to chart subtle differences between various sites. If the differences are real, the results suggest that there is considerable variability between faunal assemblages at northern Plains bison kills. Whether these differences are cultural, temporal or regional in origin remains to be demonstrated.

We may be avoiding a more obvious solution as to why the HSI kill site fauna doesn't resemble what we expect of a kill assemblage - because it was not excavated from a kill site. Reeves' excavations were placed on the bench which parallels the base of the HSI cliff. If the actual jump off and main kill were in the spring channel just to the south then the adjacent bench could have been the scene of much primary and perhaps secondary butchering. Supporting this scenario is the fact that previous excavations (Brink *et al.* 1985; Morlan 1985) and those reported on here have documented the existence in the spring channel of a faunal assemblage which is consistent with what we have come to expect of a kill site. In contrast, when viewed by % NISP, the 5,700 year faunal record recovered by Reeves from excavations along the bench exhibits remarkable similarity to a bison processing assemblage. Clearly, the intensive processing seen in the archaeological remains from the prairie is absent at the base of the cliff, as indicated by the lack of processing features in the latter location. Yet it seems possible that the bench has served as a venue for the general butchering of bison throughout the entire history of the use of HSI. This would help explain the paucity of evidence from the prairie which relates to the butchering of bison during all the Middle Prehistoric use of HSI - that work was being done up above at what has been regarded as the primary kill site.

The possibility that excavations along the cliff at HSI may have documented what is largely a bison butchering sequence rather than primary kill activity underscores the difficulty in distinguishing the "archaeological signatures" for a continuum of behaviour from kill to butchering, and stresses the need for dedicated research on this topic. It should also be noted that the faunal patterns which constitute our idea of what a kill assemblage "should look like" may be entirely unsupportable.

CHAPTER 7

LITHIC REMAINS

INTRODUCTION

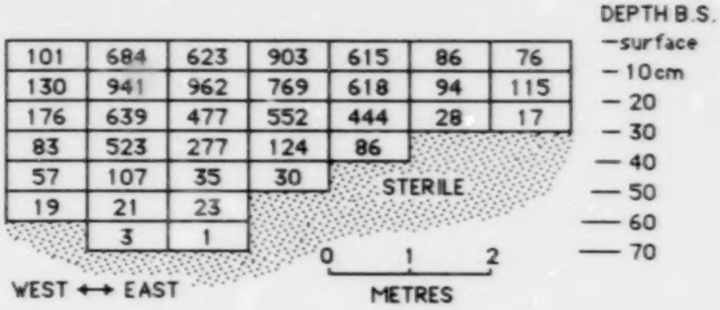
The lithic assemblage recovered from HSI in 1985 and 1986 consisted of 17,092 items, principally flaked stone tools (1,106), cores (425), and pieces of debitage (15,523), augmented by a small sample of ground and non-formed stone tools (38). The bulk of the lithic material was recovered from the processing area below the kill site, although a small sample of artifacts was recovered from three test pits in the gully of the spring channel where it cuts the kill site (Table 28).

Although the lithic assemblage was similar, in terms of relative quantities, raw materials and artifact morphologies, to that recovered in the 1983 and 1984 seasons (Brink *et al.* 1985, 1986), this assemblage provided a unique sample in that part of it was recovered from a clearly stratified deposit in the processing area. The material recovered in this area largely is Late Prehistoric in age and appears to be a continuous record, interrupted only by a uniform 8-10 cm thick layer of essentially sterile sand which occurs between approximately 25 and 35 cm below the surface in the western end of the excavation. This sterile sand layer covered approximately 11 square metres of our block area and also was the area in which the deepest cultural deposits occurred. Based on radiocarbon determinations from above and below the sand layer, it appears that this disconformity occurred sometime between 1,300 and 800 years B.P. To the east of the stratified area, the deposits become progressively shallower and more compressed, and the sterile sand lens could not be detected. Despite the compressed nature of the deposits at the eastern end of the excavation, there were indications that parts of this area did contain some stratigraphic integrity. It was also apparent, however, that this area had suffered the greatest amount of disturbance due to rodent activity and to the presence of cultural features. For these reasons, the focus of the lithic analysis was on the deeper, stratified portion of the contiguous block excavation.

Figure 73 is a cross sectional plot showing the distribution of lithic materials recovered by arbitrary 10 centimetre level in the block excavation.

Table 28. Summary of lithic artifacts recovered from DkPj-1 in the 1985 and 1986 field seasons.

ARTIFACT CATEGORY	SPRING CHANNEL				PROCESSING AREA			UNIT	UNIT	SITE TOTAL
	39	40	42	TOTAL	WELL 43	BLOCK UNITS	TOTAL	4	48	
PROJ.POINTS	8	14	7	**29**	9	273	**282**	10		**321**
HAFTED KNIVES						19	**19**		1	**20**
KNIVES		1		**1**	4	29	**33**	3		**37**
PREFORM/H.KNIVE						4	**4**			**4**
AWL/BORER						7	**7**			**7**
CHOPPER	1	1		**2**	1	30	**31**			**33**
DRILL					1	3	**4**			**4**
EDGE GROUND FLK.						10	**10**			**10**
ENDSCRAPER		1		**1**	3	63	**66**	6	3	**76**
SIDESCRAPER			1	**1**	2	43	**45**	6		**52**
SPOKESHAVE					1	25	**26**	4		**30**
MISC. UNIFACE						25	**25**	3		**28**
TRIANG. FLK. TOOL	1			**1**	1	21	**22**	2	1	**26**
WEDGE						5	**5**			**5**
MISC. BIFACE					6	114	**120**	3	2	**125**
BIF. RET. MURL					5	98	**103**	8		**111**
UNIF. RET. MURL			1	**1**	2	49	**51**	1		**53**
BIF.+UNIF.RET.MURL						5	**5**	1		**6**
UTILIZED MURL					1	112	**113**	3	3	**119**
MISC. MURL					2	35	**37**	1	1	**39**
TOOLS TOTAL	**10**	**17**	**9**	**36**	**38**	**970**	**1008**	**51**	**11**	**1106**
BIPOLAR		1		**1**	16	324	**340**	6	5	**352**
SIMPLE	1	3		**4**	3	29	**32**	1		**37**
AMORPHOUS	1			**1**		28	**28**	2	1	**32**
BIFACIAL						2	**2**	1		**3**
SPALL					1		**1**			**1**
CORES TOTAL	**2**	**4**		**6**	**20**	**383**	**403**	**10**	**6**	**425**
DEBITAGE	**5**	**20**	**13**	**38**	**329**	**14004**	**14333**	**1059**	**93**	**15523**
ANVIL						5	**5**			**5**
HAMMERSTONE						14	**14**	1		**15**
ANVIL/HAMMER						5	**5**			**5**
ABRADER						5	**5**			**5**
ARROWSFT. STRTR.						1	**1**			**1**
PESTLE		1		**1**		6	**6**			**7**
GRND. ST. TOOLS		**1**		**1**		**36**	**36**	**1**		**38**

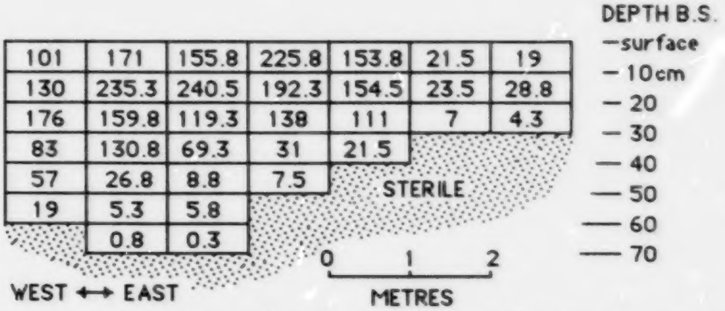


101	684	623	903	615	86	76
130	941	962	769	618	94	115
176	639	477	552	444	28	17
83	523	277	124	86		
57	107	35	30			
19	21	23				
	3	1				

Figure 73. Cross section view of block excavation showing total number of lithic artifacts per level.

Not only is the cultural deposit observed to be thicker towards the west end of the block excavation, but it is also richer in terms of the relative amount of cultural material.

The values for the unit on the extreme left in Figure 73 are low because they represent the yield of material from only 1 square metre, unit 40, whereas the other columns each represent the yield from a strip of 4 square metres. This is clarified with a conversion to the relative number of lithic artifacts per square metre as illustrated in Figures 74 and 75.



101	171	155.8	225.8	153.8	21.5	19
130	235.3	240.5	192.3	154.5	23.5	28.8
176	159.8	119.3	138	111	7	4.3
83	130.8	69.3	31	21.5		
57	26.8	8.8	7.5			
19	5.3	5.8				
	0.8	0.3				

Figure 74. Cross section view of block excavation showing number of lithic artifacts per square metre for each level.

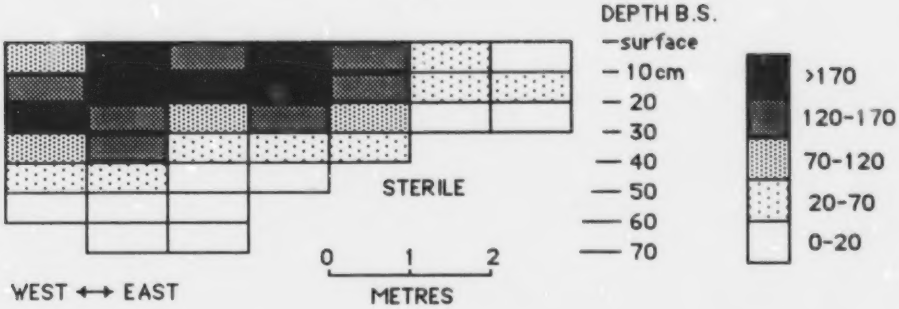


Figure 75. Cross section view of block excavation showing relative density of lithic artifacts per square metre for each level.

Excavations conducted previously at HSI (Brink *et al.* 1985, 1986; Reeves 1978, 1983a) have demonstrated a sequence of site use spanning several thousand years. Lithic assemblage characteristics, including artifact styles, raw materials and reduction strategies, were observed to undergo changes throughout the complex, stratified, multi-component deposit excavated by Reeves at the HSI kill site (Reeves 1978, 1983a). In the analysis of any prehistoric lithic assemblage, the role of function as opposed to cultural factors should be considered in interpreting assemblage variability, as has been demonstrated by the classic Mousterian debate (Binford and Binford 1966). It can be argued, however, that the processing area at HSI is a functionally discrete and specialized location in which activities changed little through the history of the site; that is, the principal activities at the HSI processing area were to butcher bison to prepare food and by-products as the direct result of a large communal kill. Lithic material therefore should reflect these activities and not those associated with other general or specialized activities. Hence, disparities between any two components in the lithic assemblage should represent cultural differences rather than functional ones.

The stratigraphic separation of cultural material in the small, stratified area at HSI gave us the first opportunity to separate the lithic assemblage from the processing area into different components. Although these relatively gross stratigraphic components are hardly discrete temporal events, we are presented with an opportunity to evaluate what changes, if any, have occurred in the lithic assemblage during the Late

Prehistoric Period. These data will be compared to the complementary kill site lithic assemblage recovered by Reeves (1978, 1983a).

METHODOLOGY

The methodology used for this analysis was adapted from that used from the first two seasons of our project (Brink et al. 1985:313-339). Other than a few modifications, the basic system of classification has remained the same.

Artifact Classes

All lithic items were sorted into either flaked stone artifacts and their by-products or unmodified and ground stone artifacts. All flaked stone artifacts were arbitrarily categorized on the basis of their level of development. Five general, mutually exclusive, developmental classes were employed:

Cores

These are the object pieces of stone from which flakes were detached for the purpose of providing pieces (blanks) for the production of stone tools.

Debitage

These are the detrital by-products of stone tool manufacture which show no evidence of use or further modification. Pieces of debitage that retain a striking platform will be referred to as "flakes" for the purposes of this report. Pieces of debitage that do not retain a striking platform will be referred to as "shatter."

Marginally Retouched or Utilized Lithic Artifacts (henceforth referred to by the acronym "MURLs")

These are stone tools which show evidence of use wear or have been retouched to produce one or more working edges. To be classified as a MURL, such modification is restricted to the margins and does not alter the morphology of more than 50% of either face.

Unifaces

These are stone tools which have been modified by the application of retouch to only one face. Retouch covers more than 50% of one face.

Bifaces

These are stone tools which have been modified by the application of retouch to both faces. Retouch covers more than 50% of one face.

Once the artifact was pigeonholed into one of the five developmental classes described above, further subdivision into arbitrary categories was undertaken, based on either a common morphology or function. Categories of cores and debitage are exclusive to those classes; however, common tool categories can occur in any one of the three classes of tools. For example, in the endscraper category, an individual artifact can be classed as either a MURL, a uniface or even a biface depending on the nature and extent of modification. A description of the individual categories will be provided in the "Artifact Descriptions" section.

Raw Materials

Raw material types were assessed on the basis of texture, hardness, color and diaphaneity. Lithic types which could be readily identified were assigned to type categories used previously (Brink *et al.* 1985, 1986); otherwise, they were classified into a general miscellaneous category based on texture. For the purposes of this report these types were condensed into 13 major groupings, based on similarities of flint-knapping properties and presumed source. These types are not intended to represent a comprehensive petrological taxonomy, but rather they are presented as archaeological types based on those materials which have been recovered at this site.

Identification of raw material types was macroscopic. Hence, further subdivision of these into proper geological taxon was hampered by a lack of further quantitative analysis which was considered impractical for this report. It might be argued that the native peoples who used these materials were similarly more concerned with flint-knapping characteristics and the sources of the desired lithic types than they were with the specific mineralogical composition. The following is a summary of the raw material types used in this report.

Chert

Chert is composed of microcrystalline quartz and chalcedony and is usually contaminated with clay, carbonates and/or iron oxides. Chert commonly is found as concretions, replacement patches and veins (Cox *et al.* 1973:206). The sources of origin for the multitude of variegated cherts found at HSI are believed to be almost exclusively Madison Formation chert from Montana, Etherington chert from the Livingstone Range in the Crowsnest Pass vicinity (Kennedy *et al.* 1986:55; Loveseth 1976a, 1976b), Top of the World chert from British Columbia (Choquette 1980-81:24-28), and pebble cherts derived from the Laurentide till and associated river gravels (see also Reeves 1978, 1983a). One of the latter types of pebble chert, Swan River chert, was considered to be distinctive enough that it was separated into a separate category. Pebble chert is also available in the Blairmore Conglomerate in the Crowsnest Pass (Loveseth 1980:164); however, the extent to which this source was exploited by the users of HSI is unknown at present.

The cherts from most of the above sources are highly variable macroscopically, and we did not feel confident that we could source them reliably by visual examination alone, particularly considering that most of the pieces of debitage weighed a tenth of a gram or less. Many cherts can be altered by heating (Crabtree and Butler 1964; Mandeville 1973; Purdy 1974), which often changes the lustre of the resulting fracture surfaces from dull or waxen to greasy and causes a variable color change. Hence, a wide variety of colours and lustre are represented. Surficial weathering and patination also can affect the appearance and obscure physical characteristics of many cherts. For these reasons, the cherts from the sources mentioned above, as well as chalcedony and silicified limestone, were combined to form a general chert category. It is our opinion that the bulk of the chert in this assemblage is derived from either the Madison Formation or from pebble cherts and that other types were not as well represented.

Swan River Chert

This peculiar variety of chert was readily differentiated from the more homogeneous cherts with better conchoidal fracture described above. Swan River chert is characterized by a mottled appearance with a spongy to vuggy texture. Color is variable, but specimens recovered at HSI are most often white, pink, beige, yellow or grey, with a white, brown or grey cortex. Campling has provided the following description of Swan River chert:

> The material also appears inhomogeneous compositionally. Clear, translucent, and opaque areas are visible. Small (less than 1 mm), opaque, irregular-shaped mottles or spots of brown, red, orange, white, or grey colour are typically present . . . . They may be peg-shaped, feather-like, or acicular (needle-like). These mottles are aggregates of quartz grains. Fracture surfaces are not affected by this apparent inhomogeneity, except where the quartz is very coarsely crystalline. The numerous small vugs and the feather-like aggregates are the most distinctive macroscopic features of Swan River chert (Campling 1980:294, 295).

Swan River chert is available as pebbles or cobbles, distributed by Laurentide glaciation, and is particularly prevalent in tills of eastern Saskatchewan and Manitoba (Campling 1980:292). We have not discovered any of this material in till or river gravels near HSI; however, it has been observed in southeastern Alberta (J. Brumley, personal communication 1986).

Knife River Flint

This material has been described as a ". . . fairly uniform, non-porous, dark-brown flint . . ." which apparently was formed by the silification of a lignite deposit of Eocene age (Clayton *et al.* 1970:287). Typically, it exhibits layered sedimentary lenses incorporating plant macrofossils with cellular microstructures in numerous orientations. Although similar to some brown chalcedony and silicified wood, the former lack the fossil inclusions that typify Knife River Flint (KRF) and the latter lack the mixed orientation of plant cells and the often folded and discontinuous nature of the individual lenses. The main, and possibly only, source of this material is in midwestern North Dakota (Clark 1982), although somewhat similar materials may be available in Saskatchewan (Eldon Johnson, personal communication 1987).

Fresh fracture surfaces of KRF tend to be relatively featureless with a dull lustre. Heating this material can improve its knapping qualities which are good even in the unaltered form (Ahler 1983). With a low temperature thermal pretreatment, flaking is improved, a slightly reddish color is imparted, and the resultant lustre is noticeably greasy. The changes in colour and lustre are accompanied by pronounced flake scar attributes, notably the enhancement and definition of ripple marks. Overheating this material has a negative effect on its flaking qualities, however, and results in a change in diaphaneity from the characteristic translucent to opaque and a color change varying with increased heat from reddish brown to black to light grey. Based on our experiments on this material, it seems apparent that most, if not all, of the KRF found at HSI has been effectively heat treated prior to reduction.

Obsidian

This is a very brittle, volcanic glass with excellent conchoidal fracture that results in very sharp edges. The specimens of this material found at HSI are mostly translucent, black and free of banding or inclusions, although opaque black to dark grey specimens are present. An obsidian source study employing X-ray fluorescence indicates that the principle known sources of the obsidian found at HSI are Yellowstone (Obsidian Cliff) in Wyoming and the Snake River in Idaho (Godfrey-Smith and Magne 1988). One other primary source of this material has not been located ("BCSIA") but is believed to originate somewhere in the northwest states, possibly Idaho (Godfrey-Smith and Magne 1988:133). One Scottsbluff point base, recovered from the surface at HSI by Boyd Wettlauffer, was sourced to Burns (area B) in Oregon. To date, no obsidian from HSI has been traced to the various sources in British Columbia.

Porcellanite

This material is described by the American Geological Institute as follows:

> A hard, dense, siliceous rock having the texture, dull luster, hardness, fracture, or general appearance of unglazed

> porcelain; it is less hard, dense, and vitreous than chert. The term has been used for various kinds of rocks, such as impure chert, in part argillaceous and in part calcareous; or more rarely sideritic; and indurated or baked clay or shale with a dull light-colored, cherty appearance, often found in the roof of burned out coal seams; and a fine grained acidic tuff compacted by secondary silica (1973:557, in Fredlund 1976:208).

As used here, porcellanite specifically refers to those materials of coal burn origin as described by Fredlund (1976). The porcellanite at HSI is usually grey or, less often, a dull red colour. Although porcellanite can be found associated with coal fields and, hence, should be available from closer sources, we believe most, if not all, of the porcellanite found at HSI is derived from southwestern and south-central Montana where large outcrops of fine quality material occur (Clark 1985). Another associated coal burn material, fused glass, was observed in this assemblage. Since only two small pieces of debitage of this material were observed (0.1 and 0.4 g), these were incorporated with the porcellanite group. Porcellanite is largely siliceous is somewhat softer than chalcedony, between 5 and 6 on the Moh's scale (Fredlund 1976:209).

Silicified Sediments

This category refers to a variety of lithified sediments, including textural classes of mudstone, siltstone and sandstone which have been bound by a silica cement.

The silicified mudstone is typically opaque with a dull flat lustre. It is usually gray in colour but can weather to a light brown. Banding of silicified mudstones used at HSI is not common. This material is quite homogeneous, and fracture surfaces tend to be smooth and unimpeded by flaws. The silicified mudstones found at HSI appear to have been derived primarily from pebbles.

The silicified siltstones tend to have a resinous lustre and a slightly grainy texture and are frequently banded with shades of varying grey (usually dark grey) to black, and occasionally brown. Lithic types referred to in Alberta as Nordegg chert or Banff chert would normally be classified here as silicified siltstone. The presence of flat bedding plane surfaces and the lack of cortex suggests that these latter materials were usually derived from bedrock outcrops, likely from sources in the nearby Rocky Mountains

(Loveseth 1980:163). Many of the opaque "black pebble cherts" so prevalent in archaeological literature in Alberta would be classified in this scheme as either silicified mudstone or siltstone depending on the texture.

Silicified sandstones are sedimentary sandstones with a very high quartz content bound in a silica cement. As used here, this material can be described as an orthoquartzite. The colors of the silicified sandstones found at HSI are predominantly light grey and occasionally dark grey. Larger individual grains are readily observed and often stand out as shiny, reflective glints in an otherwise relatively dull groundmass. Some of the light grey specimens are virtually indistinguishable from the Beaver River silicified sandstone identified in northeastern Alberta (Fenton and Ives 1982; Ives and Fenton 1983); although, we presume the source of the HSI material is much closer. Both the silicified siltstones and silicified sandstones occur in the assemblage as raw materials derived principally from primary bedrock outcrops and, to a lesser extent, pebbles, presumed to be available from several locations in the nearby Rocky Mountains.

Included in the silicified sediments group are a very few pieces of Kootenay argillite. This material is typically pale green or blue-green and is relatively fine-grained and hard; however, it is also platey, a characteristic which adversely affects its flaking properties (Choquette 1980-81:32, 33). The source of Kootenay argillite is believed to be in the vicinity of Kootenay Lake (Choquette 1980-81:33).

None of the flaking properties of these materials appears to be improved by heating, nor is the color altered significantly. With the possible exception of the Kootenay argillite, the source of the silicified sediments in the HSI assemblage is primarily regional; that is, they occur in the region exploited by the users of the jump and were rarely if ever obtained by trade. Reeves further suggests that the occurrence of Kootenay argillite at HSI is not due to trade but actually represents visitation by hunters from the B.C. interior (Reeves 1983a:124D).

Silicified Wood

This lithic type has been described as follows:

> A material formed by replacement of wood by silica in such manner that the original form and structure of the wood is

> preserved. The silica is generally in the form of opal or chalcedony (American Geological Institute 1962:454).

The silicified wood in this assemblage is of generally poor quality; fractures tend to follow the wood grain, parting into tabular blocks or sheets. This material is available locally and is scattered about the vicinity of HSI in small amounts.

Quartz

Quartz occurs in the vicinity of HSI in the form of very small lumps or pebbles of highly fractured vein quartz. The cortex generally appears white due to surface abrasion, but the interior is colorless, and small pieces are virtually transparent. The fracture is highly irregular and uncontrollable but does result in hard, sharp edges.

Quartzite

Quartzite has been described as follows:

> . . . a tough and massive rock consisting almost wholly of quartz, and it is the usual product of contact or regional metamorphism of an orthoquartzite . . . (Cox *et al.* 1973:227).

To this, Toll adds the following:

> . . . [the] basic mineralogical definition of quartzite is that it is a metamorphosed sandstone which will fracture through the constituent grains rather than around them . . . (1978:47).

Quartzite is a term applied not only to metamorphosed sandstones, or metaquartzites, but also to the silicified sandstones or orthoquartzites from which metaquartzite is derived. As used here, quartzite refers to only the metamorphic variety. For the purposes of this report, orthoquartzites are categorized as silicified sediments. The quartzites found at HSI are typically yellow, brown or gray; however, the color can vary radically upon heating, to pink, red or purple. Although heating can cause a dramatic change in colour, the flint-knapping characteristics of the quartzites available in Alberta are not improved by such treatment (Dawe 1984). Quartzite is readily available in nearby river gravels and exposed till.

Argillite

This specifically refers to the locally abundant, dull green, opaque argillite that occurs as cobbles in nearby river gravels. It appears to be the Grinnell argillite described by Loveseth (1980:175,176). Argillite is described as a ". . . siltstone, claystone, or shale that has undergone a somewhat higher degree of induration [hardening as a result of lithification] than is present in those rocks" (American Geological Institute 1962:23). The texture of the local argillite is highly variable, ranging from a relatively coarse, siltstone texture to a fine, almost chert-like texture, but the majority is of the siltstone grade. Although this material is harder than siltsone, it can be scratched readily with a knife. Bedding is apparent in some specimens, but it does not often affect the fracture, which is generally poor anyway. The green argillite at HSI turns red or brown upon heating, with no observed improvement in flaking characteristics.

Non-silicified Sediments

As used here, this term refers to fine-grained, sedimentary rocks, principally limestones, siltstones and mudstones and, to a lesser extent, shale. The principle distinction between the latter two is that shales tend to break along flat bedding planes while mudstones do not. All materials in this class are relatively soft and lack the qualities of brittleness and conchoidal fracture. The adverse effects of hydration on some of the artifacts obviously has rendered them into a more friable condition than would have existed when the artifacts were formed. In some cases, weathering has obliterated surface features and, particularly with the limestones, may have completely removed evidence that some of these were formed into or used as tools. Most of the siltstones and mudstones are beige, grey, yellow or, rarely, black. The shales tend to be grey. The limestone found here is usually quite homogeneous and has a grey colour on a fresh surface, weathering to an almost white colour. Some of the mudstones and siltstones turn red upon heating, but it is unlikely that flaking properties are improved by such treatment. Most of these materials are available locally.

Sandstone

This is almost exclusively the calcareous Porcupine Hills Formation sandstone which outcrops at HSI. This material is coarsely textured and has an opaque diaphaneity with a dull lustre. Usually brown to greenish brown in colour, it can redden and become quite friable upon heating. Although this material has very poor fracture characteristics, a fresh surface has excellent abrasive qualities.

Miscellaneous Coarse

Any coarse-grained rock which did not fit the above descriptions was thrown into this catch-all category. Some rock types included are granite, schist, gneiss and conglomerate. These rocks are considered generally unfit for flaking; however, percussion flaking of some of these materials can facilitate the roughing out of certain ground stone tools.

The above list of raw materials is hardly exhaustive, but it does account for the great majority of the materials observed in the HSI assemblage. Despite the careful scrutiny of each specimen, some rock types may have been identified incorrectly and placed in a textural category similar to a material having a different composition. A likely candidate for such misidentification is basalt, which was not observed in the assemblage recovered during the 1985 and 1986 seasons. It is possible that a small amount of fine-grained basalt was imported to the site; however, its surficial characteristics, as observed macroscopically, so closely resemble some of the silicified sediments that it probably would be classified as such.

The particular methodology and variables employed for each artifact class are provided in the appropriate artifact descriptions sections below. These descriptions pertain only to the materials recovered from the excavation of the block area of the processing site and to the sample recovered from the test pits in the spring channel. The material recovered from the completion of unit 4, which was opened in 1983 (Brink *et al.* 1985, 1986), as well as from the partial excavation of unit 48 was not included in this analysis; however, a list of items recovered from these two locations is included in Table 28.

ARTIFACT DESCRIPTIONS

Tools

All lineal measurements were obtained with sliding calipers to the nearest tenth of a millimetre. Weights of all artifacts were determined with a digital balance to the nearest tenth of a gram. Weights which were less than 0.05 grams were rounded off to zero. Based on the relative amount of cortical surface, a value was assigned from 0 to 4. These values correspond to a range of the percentage of the relative amount of the entire surface which is covered with cortex, (0 = no cortex present; 1 = 1 to 25%; 2 = 26 to 50%; 3 = 51 to 75%; and 4 = 76 to 100% cortex). Cortex values presented below are an average of these codes on a scale of 0 to 4 rather than an actual percentage. For example, a tool category having a relatively high cortex value of 2.3 would indicate a tool type typically having more than half of the surface covered with cortex, whereas a small value of 0.23 would indicate most specimens would have no cortex. A summary of the flaked stone tool categories described below and the raw material types represented in those categories is provided in Table 29.

Projectile Points (n=311)

This artifact category accounts for thirty percent of the flaked stone tool assemblage and occurs in greater numbers than any other tool type at the processing site (see Figures 76 to 81). Considerable difficulty was encountered in trying to type these artifacts, particularly the Late Prehistoric arrowheads which vary considerably in morphology, workmanship, integrity and raw material. The typology and analytical procedure employed follows that used in the 1983 and 1984 investigations at HSI (Brink *et al*. 1985, 1986).

To assist in interpreting the relative stratigraphic provenience and age of projectile points recovered from the block excavation, a schematic cross section view of the excavation area has been provided (Figure 82). This figure plots the units of provenience from which dated materials were obtained. A similar cross sectional view will be used throughout the remainder of this section to illustrate the vertical distribution of various projectile point types.

Table 29. Frequencies of raw materials in tool categories.

	TOOLS OF EACH RAW MATERIAL TYPE (N)													
TOOL CATEGORIES	CHERT	SRC	KRF	OBS.	PORC.	SIL.SED.	SIL.WD.	QUARTZ	QTZITE	ARG.	NON.SIL	SANDST	M.CRSE.	TOTAL
PROJECTILE POINT	130	67	12	19	11	37	15		20					311
HAFTED KNIFE	3	8				2	1		5					19
KNIFE	5	10			3	6			9	1				34
PREF./HAFT. KNIFE	2	2												4
AWL/BORER	1	1	2	2			1							7
CHOPPER						1			18	7	5	1	1	33
DRILL	4													4
EDGE GRND. FLAKE						1			3	2	1	1	2	10
ENDSCRAPER	48	2	4		1	11	1							67
SIDESCRAPER	19	4			1	8	1	1	10	1		1		46
SPOKESHAVE	9	3	2	1		9			1		1			26
MISC. UNIFACE	21	2	1			1								25
TRIANG. FLK. TOOL	14	5			2	2								23
WEDGE						3	1		1					5
MISC. BIFACE	60	17	7	5	1	15	8	1	6					120
BIF. RET. MURL	16	9		4	1	8	53		6	3	1	1	1	103
UNIF. RET. MURL	17	11	1	1	1	7	1		10	2	1			52
BIF.,UNIF.RET.MURL		2		2					1					5
UTILIZED MURL	32	23	5	7		13	2	1	15	11	2	1	1	113
MISC. MURL	15	4	1	1		5	2		4	5				37
TOTAL	396	170	35	42	21	129	86	3	109	32	11	5	5	1044

	TOOLS OF EACH RAW MATERIAL TYPE (%)													
TOOL CATEGORIES	CHERT	SRC	KRF	OBS.	PORC.	SIL.SED.	SIL.WD.	QUARTZ	QTZITE	ARG.	NON.SIL	SANDST	M.CRSE	TOTAL
PROJECTILE POINT	41.80	21.54	3.86	6.11	3.54	11.90	4.82		6.43					100.00
HAFTED KNIFE	15.79	42.11				10.53	5.26		26.32					100.00
KNIFE	14.71	29.41			8.82	17.65			26.47	2.94				100.00
PREF./HAFT. KNIFE	50.00	50.00												100.00
AWL/BORER	14.29	14.29	28.57	28.57			14.29							100.00
CHOPPER						3.03			54.55	21.21	15.15	3.03	3.03	100.00
DRILL	100.00													100.00
EDGE GRND. FLAKE						10.00			30.00	20.00	10.00	10.00	20.00	100.00
ENDSCRAPER	71.64	2.99	5.97		1.49	16.42	1.49							100.00
SIDESCRAPER	41.30	8.70			2.17	17.39		2.17	21.74	2.17		2.17		100.00
SPOKESHAVE	34.62	11.54	7.69	3.85		34.62			3.85		3.85			100.00
MISC. UNIFACE	84.00	8.00	4.00			4.00								100.00
TRIANG. FLK. TOOL	60.87	21.74			8.70	8.70								100.00
WEDGE						60.00	20.00		20.00					100.00
MISC. BIFACE	50.00	14.17	5.83	4.17	0.83	12.50	6.67	0.83	5.00					100.00
BIF. RET. MURL	15.53	8.74		3.88	0.97	7.77	51.46		5.83	2.91	0.97	0.97	0.97	100.00
UNIF. RET. MURL	32.69	21.15	1.92	1.92	1.92	13.46	1.92		19.23	3.85	1.92			100.00
BIF.,UNIF.RET.MURL		40.00		40.00					20.00					100.00
UTILIZED MURL	28.32	20.35	4.42	6.19		11.50	1.77	0.88	13.27	9.73	1.77	0.88	0.88	100.00
MISC. MURL	40.54	10.81	2.70	2.70		13.51	5.41		10.81	13.51				100.00
TOTAL	37.93	16.28	3.35	4.02	2.01	12.36	8.24	0.29	10.44	3.07	1.05	0.48	0.48	100.00

Artifacts recovered from the 3 metre wide section on the west (left) end of the excavation illustrated in Figure 82 are from the stratified, undisturbed portion of the block excavation. This stratigraphy was not apparent at the east (right) end of the excavation where the deposit was compressed and partly disturbed, both by rodent activity and the presence of pit features. A complete list of metric and non-metric attributes obtained from the projectile point sample is provided in Appendix 4. The methodology used to obtain these values, originally outlined in the 1983 field season report (Brink *et al.* 1985), has also been repeated in Appendix 4.

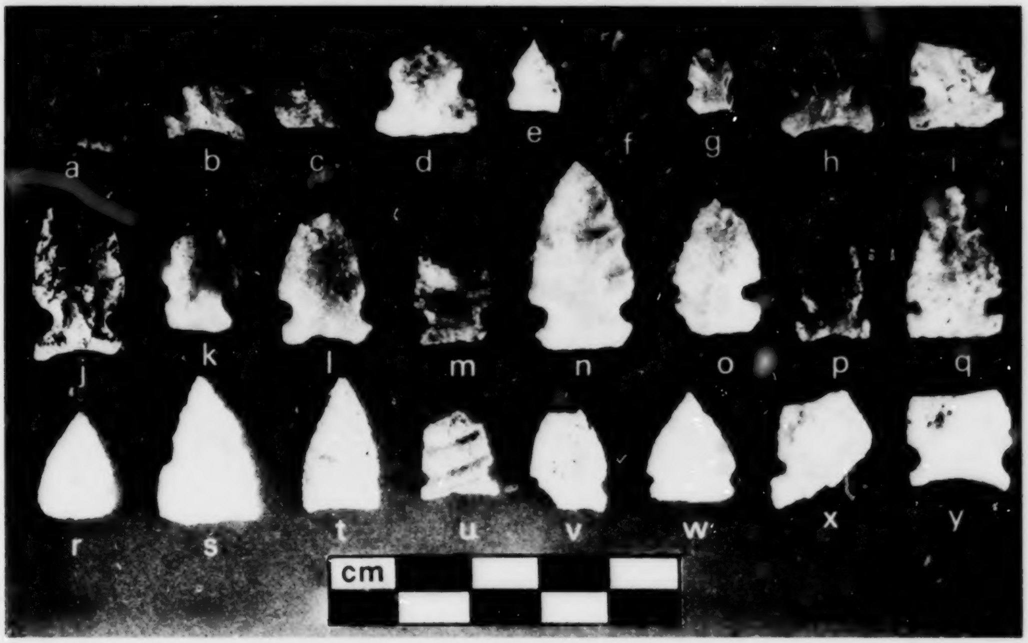


Figure 76. Projectile Points - Old Women's: a-q, x; Triangular Preforms: r-t; Avonlea (Timber Ridge variety): u-w, y. Note the extensive reprofiling of the blade edges on specimens c and d. Old Women's points e, f and g are considered to be toys.

Old Women's Projectile Points (n=112)

These are small, mostly side-notched projectile points with dimensions that are assumed to be indicative of arrowheads (e.g., Figures 76 to 79). For the most part, these specimens share morphologies that are comparable to the Old Women's Phase materials as described by Forbis (1962, 1977), and are included in the Small Side-notched Point System of Kehoe (1966, 1973). The use of the term "Old Women's" for an array of small, predominantly side-notched arrowheads dating to the latter part of the Late Prehistoric Period is a departure from our previous terminology (Brink *et al.* 1985, 1986). This is not from any sense of conviction that, as a group, these projectile points convey either discrete temporal or ethnic sensitivity. Rather, we believe that the Old Women's designation is a less ambiguous term than the "Small Notched" category used previously. It can be argued that, given the diversity of morphologies which have been

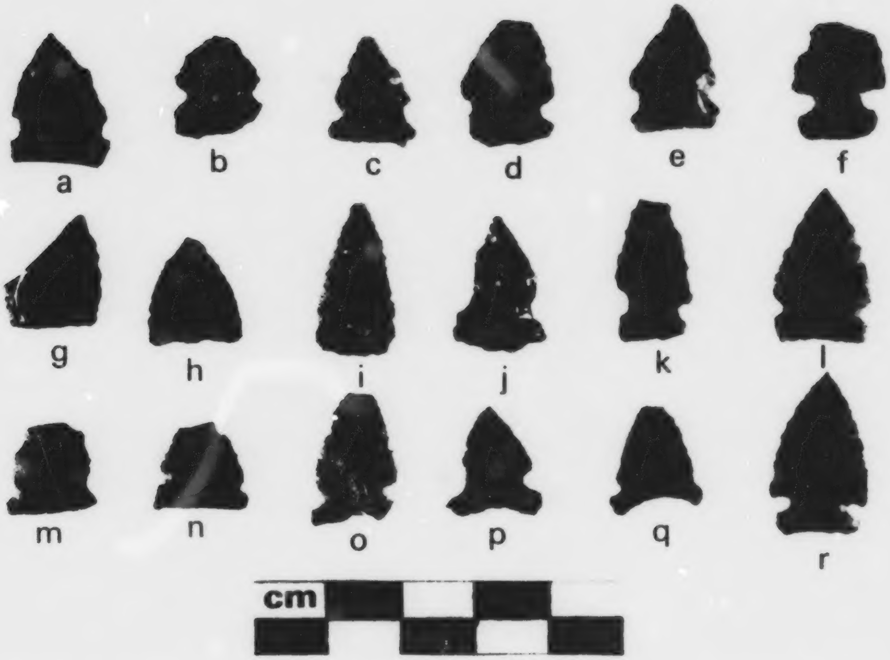


Figure 77. Projectile Points - Old Women's: a-f, j-l; Triangular Preforms: g-i; Avonlea (Timber Ridge variety): m-q; Avonlea (Head-Smashed-In variety): r.

assigned to the Old Women's Phase in southern Alberta, it is unlikely that a small, side-notched arrowhead with a different cultural affinity could be distinguished unless it had a very peculiar morphology, such as the Avonlea point style, or was made out of a particularly aberrant raw material.

Of the Old Women's projectile points, 30 are complete; the remainder are missing the distal tips (22), are represented by bases (26) or midsections (12), or are missing part of the base (22). Where the base is present, it is either straight (49), concave (20), convex (9) or irregular (9). Four specimens retain a small cortex surface; otherwise, cortex is absent. Of the 20 specimens that exhibit edge grinding, 11 have grinding restricted to the base edge only; on the others, grinding extends up the stem edges as well.

The stratigraphic position of those projectile points which most closely resemble the Plains and Prairie types of Kehoe (1966, 1973) is compared in Figures 83 and 84. The relative stratigraphic position of these is accordant with our expectations, based on the known temporal range of these two

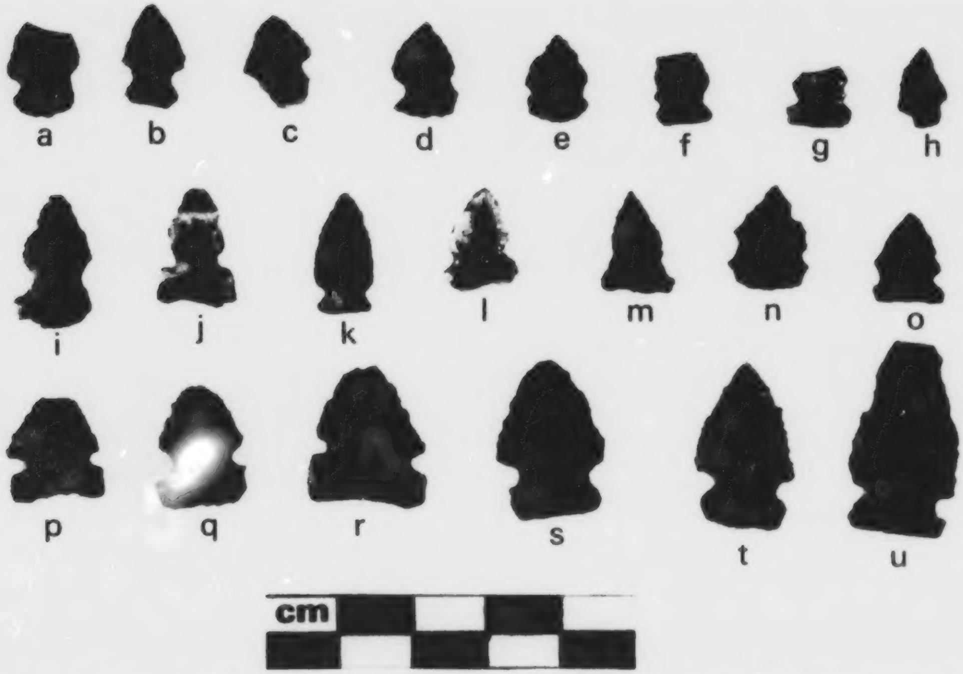


Figure 78. Projectile Points - Old Women's: a-g, i-n, p-u; Small, Stemmed: h; Avonlea: o. Projectile points a-h and k-o are considered to be toys.

point styles. It should be noted, however, that other, less "classic" points of the Old Women's variety proliferate in both levels 1 and 2, as illustrated in Figure 85. No attempt to further classify these points into the schemes of Forbis (1962, 1977) and Kehoe (1966, 1973) was attempted other than a notation of similarity where evident. Such attempts met with considerable frustration during previous analyses of similar points at this site (Brink *et al.*1985, 1986). Our reluctance to segregate these small arrowheads into subtypes was based on the fragmentary nature of much of the sample, a lack of bilateral symmetry on many of the complete specimens, and our observation that some of the variability is affected by raw material constraints. In addition, we are convinced that some of these projectile points, particularly the presumably expediently made, marginally retouched flake points, have a morphology which is more fortuitous than contrived. A similar difficulty in subdivision was encountered by Byrne in his analysis of projectile points from the nearby Morkin site (Byrne 1973).

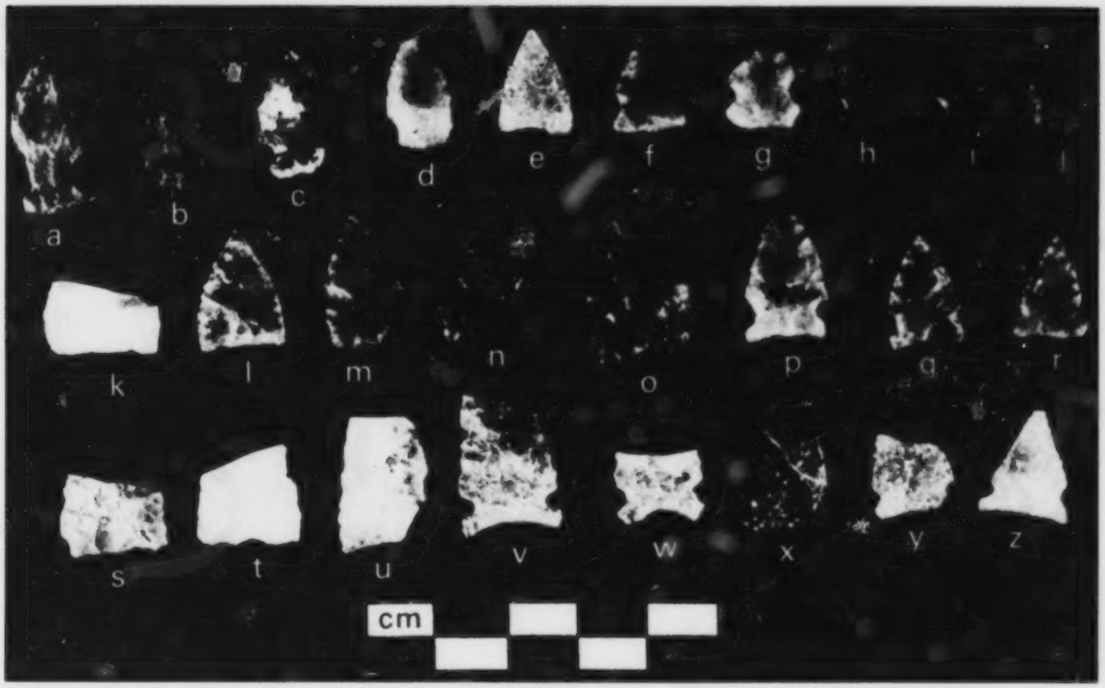


Figure 79. Projectile Points - Old Women's: a-c, f-j, m-o; Small, Stemmed: d; Triangular Preforms: e, k, l, s-u; Avonlea (Timber Ridge variety): p-r, v-z. Old Women's points g-j are considered to be toys.

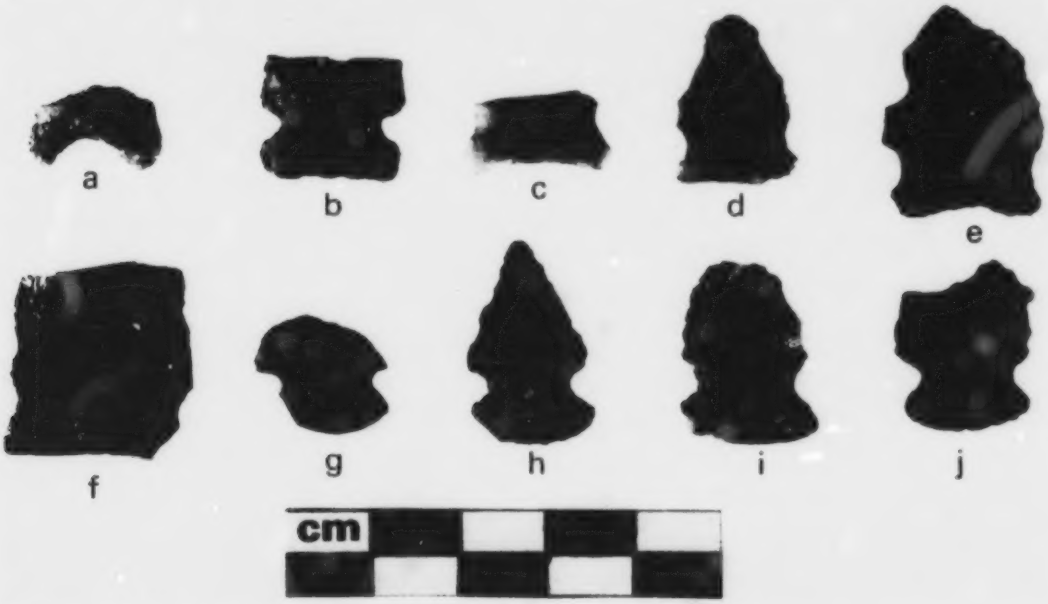


Figure 80. Projectile Points - Pinto/Elko Eared: a; Northern Side-notched/Bitterroot: b; Besant Type 1: c-e; Besant Type 2: h-j; Shallow Notched Lanceolate: f; Pelican Lake: g.

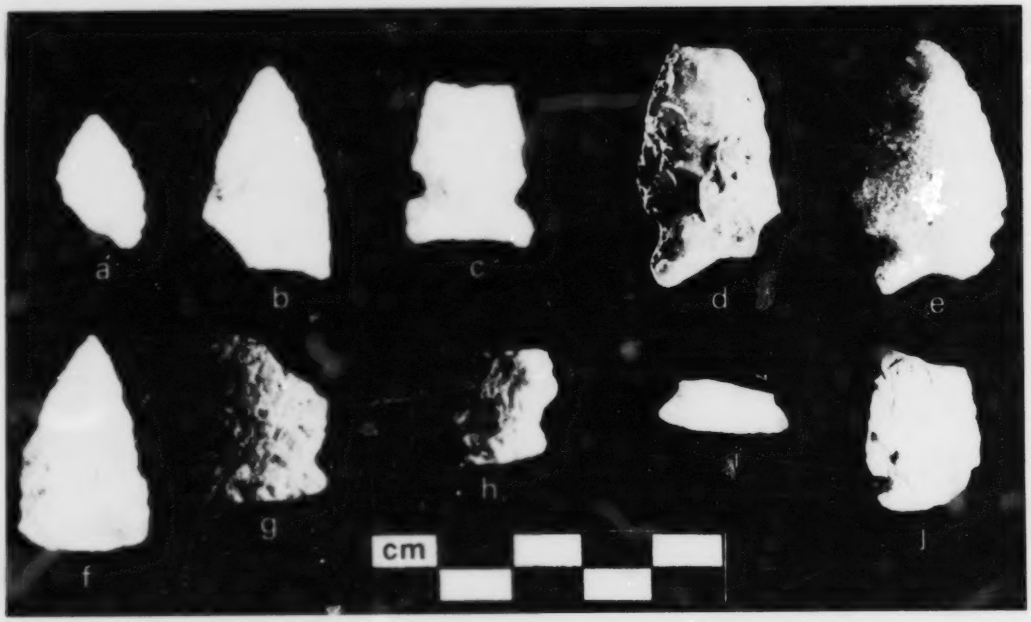


Figure 81. Projectile Points - Lanceolate: a, b; Northern Side-notched/ Bitterroot: c; Oxbow/Lewis: d,e; Triangular Preform: f; Besant Type 2: g, h; Pelican Lake: i; Miscellaneous Dart Point: j.

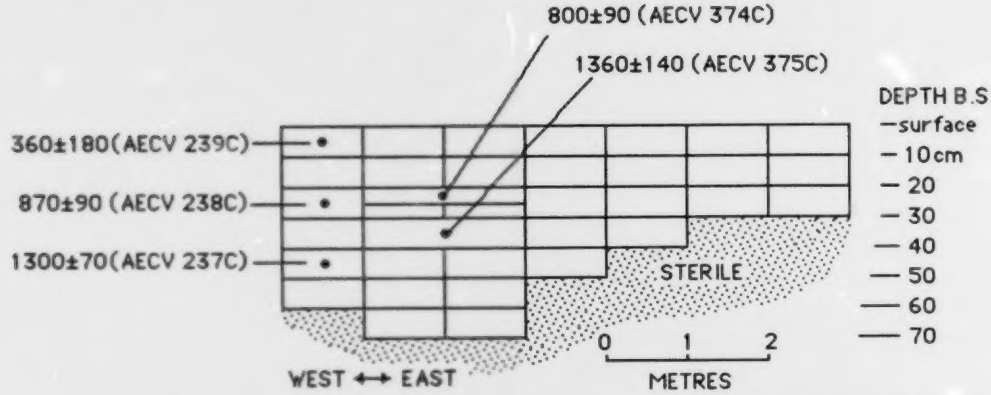


Figure 82. Schematic cross section of block excavation at DkPj-1 illustrating approximate provenience of bone samples submitted for radiocarbon determinations.

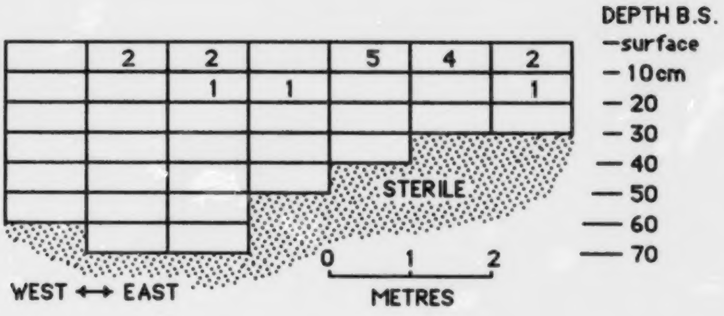


Figure 83. Vertical distribution of Old Women's projectile points most similar to the Plains type.

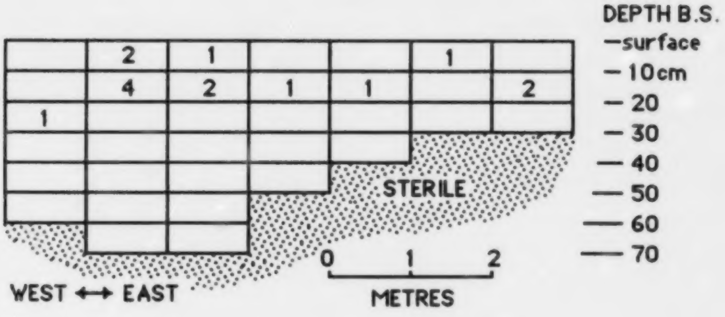


Figure 84. Vertical distribution of Old Women's projectile points most similar to the Prairie type.

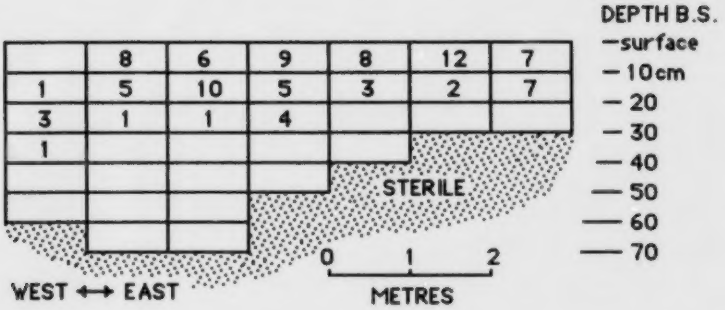


Figure 85. Distribution of all Old Women's arrowheads by level in the block excavation at DkPj-1.

Byrne avoided this problem by classifying these points as "Side Notched Arrow points" (1973:243).

The vertical distribution of the complete sample of "Old Women's" projectile points from the block excavation is presented in Figure 85. It is apparent that these points are confined to the later occupation levels of the site, in a stratigraphic position dating to the latter half of the Late Prehistoric Period. In the stratified, west half of the excavation, all of the Old Women's projectile points are in a stratigraphic position which is either contemporary with or more recent than the radiocarbon dates of 800 ± 90 years B.P. (AECV 374C) and 870 ± 90 years B.P. (AECV 238C), with the exception of one stubby and extensively reworked Swan River chert specimen (no. 61263). The lack of any Old Women's points in the extreme upper left of Figure 85 can be attributed to a small sample size. It will be recalled that this portion of the graph is composed of a single square metre. The comparable samples from adjacent units indicated in the figure are composed of 4 metres of excavation rather than 1.

In addition to the 97 Old Women's points recovered from the block excavation, a total of 12 specimens was recovered from the spring channel and three from the well-head excavation (unit 43). Most of the projectile points in these two smaller samples are broken and unusable. At least nine specimens have undergone attempts at rejuvenation, resulting in a reprofiling of the blade edges. In four such cases, the resulting point looks like it would be of little utility even though it would be classified as "complete". Two of these (nos. 69070 and 75282; Figure 76c and d) are similar to specimens recovered during the 1984 excavations (Brink *et al.* 1986:119) and appear to have been used for tasks other than as projectile points.

The raw materials used in the manufacture of the Old Women's points are illustrated in Figure 86. Although this illustration conveys the impression that only a few different raw materials were employed by the makers of these points, it should be emphasized that a tremendously wide variety of fine grained siliceous materials are represented. The heterogeneity of the cherts, in particular, suggests a number of origins which can not be accounted for by local pebble cherts or regional quarries.

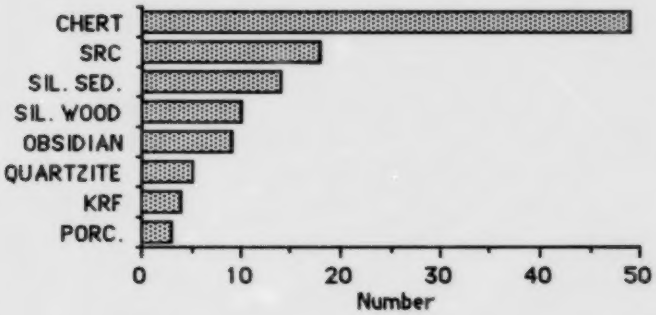


Figure 86. Raw material frequency in Old Women's projectile point category.

It has been demonstrated that temporally sensitive, stylistic changes are evident in the design of Old Women's Phase projectile points (Forbis 1962; Vickers 1986). Forbis (1962:90-91) observed that the height of the basal edge of the Old Women's points increased from the earlier to the later components, coincident with a narrowing of the notches, and that the ratio obtained by these attributes may be combined to provide an index of relative age. Kehoe's (1973:64, 69) work with the Gull Lake site materials supports this conclusion. We plotted the mean proximal lateral edge height, neck width and notch widths obtained from the sample of Old Women's points (n=42) recovered from the stratified area (Figure 87; Table 30). In Figure 87, the proximal lateral edge measurement ("PROX.LAT.EDGE") corresponds to the basal edge as used by Forbis. (We prefer to use the different, perhaps more unwieldy, terminology to avoid confusion with the proximal edge of the base, which is also referred to as the basal edge for discussion of basal edge grinding.) See Appendix 4 for clarification of these measurements.

Figure 87 reveals a trend towards shifting the lower notch juncture higher up from the base, with the increase in height of the proximal lateral edge. As can be expected, there is also an accordant shift of the neck higher up from the base, but with less change than observed with the proximal lateral edge measurement. At the Morkin site, Byrne (1973:246) also observed of Side Notched Arrow points that there was an apparent shift in the notch form from a more open "U" shape typical of the earlier level 3 materials to a more closed rectangular form in the more recent level 1. The data in Figure 87 may indicate the existence of a similar trend at HSI, whereby the gradual closing or narrowing of the notch is indicated by the closer correspondence between the height of the neck with height of the lower notch juncture.

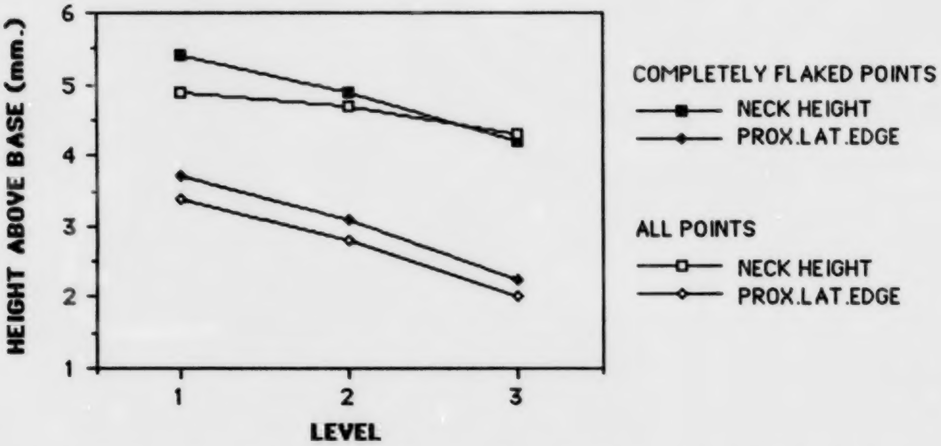


Figure 87. Mean height of proximal lateral edge and neck exhibited by Old Women's projectile points from the stratified processing area at DkPj-1.

Measurements of the actual notch opening on the entire sample from the stratified area failed to yield the expected result (that there would be a reduction of this value through time). When we considered only the completely bifacially retouched specimens in the sample, a slight reduction in the notch opening between levels 3 to 1 was observed (Table 30). The frequency of notch shapes in particular levels was difficult to evaluate given the lack of bilateral symmetry on many of these specimens. When the frequencies of the shapes of single notches were tabulated, a trend towards closed notches and a concomitant reduction of open notches were observed (Table 30).

Table 30. Notch characteristics of Old Women's projectile points from the stratified processing area at DkPj-1.

Level	Notch Opening	Closed	Open
1	3.28 mm	5	8
2	3.33 mm	1	18
3	3.48 mm	0	7

As our sample size of Late Prehistoric arrowheads from the processing area has increased, there has been an accordant increase in the number of very small and usually poorly made flake points which fall into the "fortuitous style" category as suggested above. We feel that a number of these points are simply children's toys (see Figures 76e, f and g, 78a-h and 79g-j) and that their occurrence, particularly in the processing area assemblage, adds morphological noise to what otherwise might be an assemblage more amenable to sorting into discrete, temporally sensitive types. On such small points, the outline symmetry is often the result of selecting a symmetrical flake blank with which a desired form can be achieved readily with a little marginal, often only unifacial, retouch. Most of these tiny specimens simply do not have the size necessary to facilitate hafting onto an arrow shaft of the standard parameters used by adults. Grinnell has discussed the requirements of a functional arrow:

> There was a great difference in arrows, and it was essential for the best work that the shaft should be properly proportioned. The proportions between the shaft, head, and feather were quite definite, and if these were preserved the arrow did excellent work; otherwise it was a failure . . . . An arrow too light in the shaft would not fly steadily; one too heavy would not carry its force long enough (Grinnell 1923:178).

There is ample ethnographic evidence which indicates that male youths were encouraged to use, and were supplied with, small bows and arrows at an early age to practise the archery skills upon which they would depend in later life. This practical education began at the age of only 2 years among the Kutenai (Turney-High 1941:117). We feel it is reasonable to assume that at some point during this learning process some of these toy arrows would be fitted with toy arrowheads of dimensions of proportional size. There is some evidence to suggest that the actual size of the bow and arrows was dependent upon the size of the child. Thus, a size continuum may be represented, ranging from unusually small points to those having the optimum dimensions for adult weaponry. Particularly small arrowheads, such as those illustrated in Figures 76, 78 and 79, might be confidently identified as toys; however, larger ones might be impossible to differentiate.

A study by Thomas (1978:467) on ethnographic arrow specimens illustrated a significant positive correlation between three separate point attributes with overall shaft proportions: point length, width and neck width. Given the fragmentary nature of points in the HSI sample, the attributes most useful in distinguishing toys is the neck width. To ensure successful hafting, the neck width ideally should be approximately equal to or slightly larger than the diameter of the shaft (Christenson 1986:119). Such a correspondence is also indicated in the data presented by Thomas (1978:462-466). In Figure 88, the neck width of the points that were completely bifacially flaked and that showed no trace of the original blank is plotted against the neck width of those which were not as completely flaked. The size range of widths shows the expected bell-shaped distribution. What is of particular interest, however, is that those points with necks widths of 8 mm or more show a relatively greater investment of energy involved in their fabrication; that is, they are more often completely flaked and, thus, are less likely to have functioned as toys. Of the completely flaked points with neck widths smaller than 8 mm, two appear to have been salvaged reworked tips of larger broken tools.

Grinnell observed that one of the important tools used by the Cheyenne in the fabrication of arrow shafts was a ". . . rib with a circular hole the exact size of the completed shaft, for standardizing the diameter of the tool"

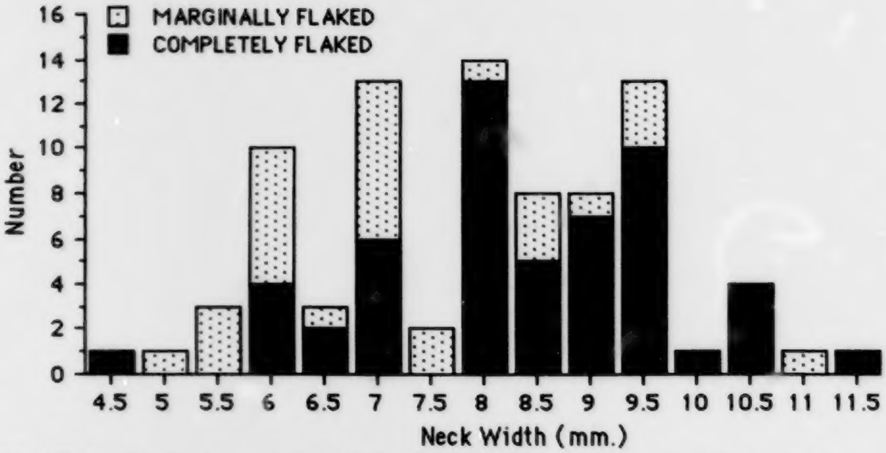


Figure 88. Plot of relative neck widths of Old Women's projectile points from the stratified processing area at DkPj-1.

(1923:179-180). If we assume a similar concern for shaft diameters among the users of HSI, the data in Figure 88 suggest that the preferred neck width for Old Women's points was between 8 and 9.5 mm. Furthermore, it can be suggested that the ideal diameter of arrow shafts to fit these points was within, or just slightly below, this same metric range.

The occurrence of toys could be expected to be relatively higher in a camp site situation, such as the processing area, and reduced in specialized task sites, such as the HSI kill site. Despite the fact that toy arrowheads would tip small arrows used by children, they would still function as projectiles, and, regardless of whether the sought after game was birds and ground squirrels or bison, breakage patterns would correspond to their larger counterparts. The importance of the recognition of toys in an assemblage has less profound implications from a strictly functional perspective than those of a culture-historical nature, particularly if it can be demonstrated that culturally or temporally sensitive attributes are less likely to be developed on toys than on the more utilitarian specimens for which design features would be more critical. The inclusion of toys in a statistical analysis of projectile points would bias the results towards smaller values and lend morphological heterogeneity to a sample which otherwise might contain styles that do have some culture-historical significance. A review of Figure 88 illustrates the disparate effect of considering flake points in a sample as opposed to just the extensively modified (completely flaked) specimens. In some circumstances, it may be appropriate to disregard demonstrably expediently fashioned projectile points completely from statistical calculations, particularly where metric attributes are used as indices to make predictions regarding culture history.

Avonlea Projectile Points (n=29)

A total of 29 Avonlea specimens was recovered in the 1985/86 seasons (e.g., Figures 76 to 79). Nine of these can be considered essentially complete, and another eight are complete except for the truncation of a small portion of the distal tip. The remainder are missing most of the blade (4) or the tip and one corner (8). Most are characterized by excellent workmanship, diminutive notches placed low on the blade, and either a straight (10) or mildly concave (12) base. Basal edge grinding was poorly developed (8) or absent on most specimens. Basal grinding, where present, occurred on either the base edge only (5), the entire base and stem (3), or, in one case, only the notches. Bifacial flaking has obliterated the blank characteristics on all but three of the artifacts; two retain a remnant ventral flake scar, and one has a small cortical surface. One red porcellanite specimen (Figure 77r) has the small, barbed shoulders characteristic of the Head-Smashed-In variant of the Avonlea type as defined by Reeves (1983b); otherwise, all can be considered Timber Ridge Side Notched variants (Reeves 1983b). The relatively short, stubby appearance of several specimens apparently is the result of resharpening; however, at least one small specimen of silicified sediment (no. 67053; Figure 78o) shows no evidence of resharpening and may represent a toy, as described above. The raw materials represented include Swan River chert (SRC) (9); chert (9), four of which are brown silicified limestone and two are dendritic gold, possibly Madison Formation cherts; silicified sediment (4); quartzite (3), two of which are a translucent vitreous grey variety; silicified wood (2); and one each of porcellanite and obsidian. The raw material types represented are summarized in Figure 89.

Five Avonlea points were recovered from the spring channel, and, of the 24 processing area specimens, ten were recovered from the stratified area. The vertical distribution of Avonlea points from the block excavation is plotted in Figure 90.

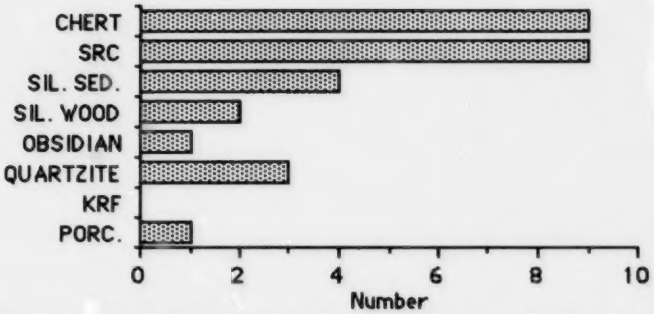


Figure 89. Raw material frequency in Avonlea projectile point category.

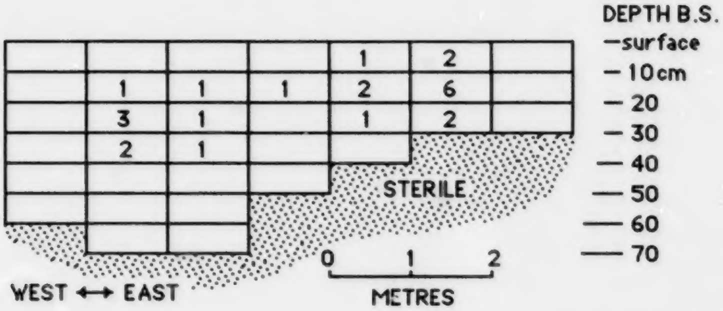


Figure 90. Distribution of Avonlea points by level in the block excavation at DkPj-1.

Triangular Point Preforms (n=46)

These specimens bear morphological similarity to finished projectile points, except for the absence of a hafting modification (e.g., Figures 76 to 79 and 81). None of these have notches, edge grinding or impact fractures indicative of use as projectile points, nor do any exhibit wear indicative of an alternate use. These appear to be preforms in a stage which would require only the addition of notches to produce a finished point. All were recovered in the processing area; three were found in the well-head excavation. The lack of unnotched preforms in the spring channel supports an interpretation that these were not ready to be used as projectiles.

Most of the specimens are broken to some degree (32), including missing part of the tip (22), missing part of the both base and tip (7), or missing part of the base (3). Breakage appears to be the result of either reduction failures or trampling rather than use. At least two specimens appear to have been broken transversely in the process of notching. Of interest is one Old Women's projectile point of Knife River Flint (no. 64555; Figure 79m). This artifact apparently was broken after the near completion of one notch. This specimen was found *in situ*, and a very careful excavation of the surrounding matrix produced only one small piece of Knife River flint debitage, which appears to be a notching flake from this artifact. Thus, it is suggested that the point, apparently not manufactured in the excavation area, was broken in the process of notch completion.

These notch-ready point preforms may have been brought to the site in near finished form and may have been obtained in that form by trade (Dawe 1987b). Given the short use lives and high discard rates of projectile points, as evidenced by the large number of broken projectile points found on site, spares obviously would have been highly desirable. It would be expected, however, that manufacture of some projectile points was undertaken on the site and that some of these points do represent the rejects of specimens which were produced here. The breakage patterns exhibited by some specimens show evidence that breakage occurred during the final thinning of the blank.

The preforms recovered include several very fine specimens of exotic materials that bear remarkable similarity to some finished projectile points of the same raw materials. Furthermore, many of the triangular preforms exhibit workmanship comparable to Avonlea specimens. A comparison of the relative stratigraphic position of the preforms (Figure 91) indicates a greater degree of association with Avonlea points than with later Old Women's material. It is suggested, therefore, that the unnotched, triangular points are preforms that were brought to the site primarily during Avonlea times.

The majority of the specimens have approximately straight bases (27), while most of the remainder are either concave (7) or convex (4). One of the latter, the largest specimen in the sample, was found near the base of the deposit in level 6 (Figure 91). This complete Swan River chert specimen (no. 78863; Figure 81f) is well made and is the only artifact in this sample which is of a size likely to represent a dart point.

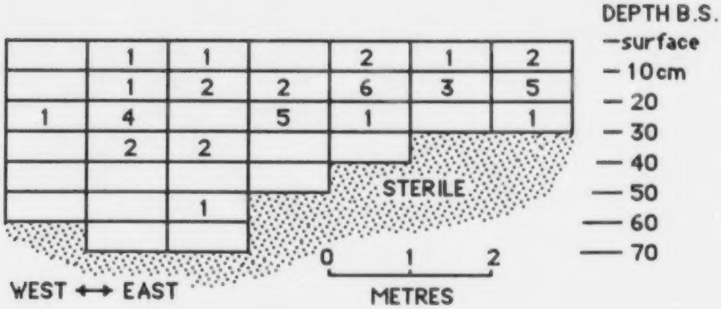


Figure 91. Distribution of Triangular point preforms by level in the block excavation at DkPj-1.

At least four of the triangular preforms are poorly made, marginally retouched tools of a diminutive size which might indicate that they were intended to function as toys. One each are made of Swan River chert, porcellanite, obsidian and Knife River flint.

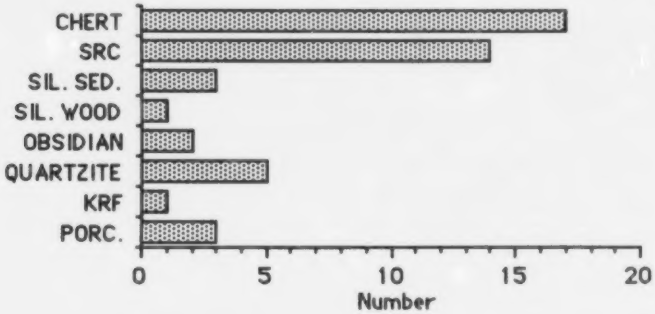


Figure 92. Raw material frequency in triangular point preform category.

Small Stemmed Projectile Points (n=2)

These specimens were differentiated on the basis of small size and a hafting modification involving removal of the corners rather than notching (Figures 78h and 79d) . Both were recovered from level 2 of the block excavation. The similarity ends there. The larger specimen (no. 70631; Figure 79d) has a square stem separated from a trianguloid blade by diminutive shoulders. It is made from a small, thick chert flake and bears metric and morphological similarity to specimens recovered previously in the processing area at HSI (Brink *et al.* 1985:121, 1986:129). The smaller specimen (no. 74246; Figure 78h) is made of silicified siltstone and is a very good candidate for consideration as a toy. Although it is the smallest artifact with the shape of a projectile point found on the site, it has been unifacially retouched around almost the entire periphery to produce the desired shape.

Besant Projectile Points (n=12)

Twelve specimens were classified as Besant dart points on the basis of overall size and morphology (e.g., Figures 80 and 81). Considerable variation exists within this small sample, but these disparate morphologies have been lumped into two gross categories to facilitate description:

Besant Type 1 (n=6)

These specimens have a straight to slightly concave base and angular basal corners which exhibit very small, obliquely oriented, proximal lateral edges (e.g., Figure 80c-e). Notching was directed inwards from the side and resulted in very broad, shallow notches that start close to the base. None is complete. Four are represented by base or base fragments (Figure 80c), one by a stubby specimen with an extensively reworked blade (Figure 80d) and the last by a specimen which has almost one whole face and much of one edge removed by potlidding (Figure 80e). Three are made of Knife River Flint and one each of chert, silicified mudstone and a particularly fine quality silicified wood. The latter two have little or no basal grinding except on the inside of the notches; otherwise, basal grinding is well developed on the entire base. All specimens were recovered in the contiguous block excavation. Although only two were recovered from the deeply stratified west end of the excavation in levels 4 and 5, all were recovered near the bottom of the cultural deposit in each of their respective units. The distribution of these points is illustrated in Figure 93.

Besant Type 2 (n=6)

These specimens differ from Type 1 specimens in that they have a convex base and broad, parabolic notches that meet the base at rounded, acutely angled, laterally projecting junctures (e.g., Figures 80h-j and 81g

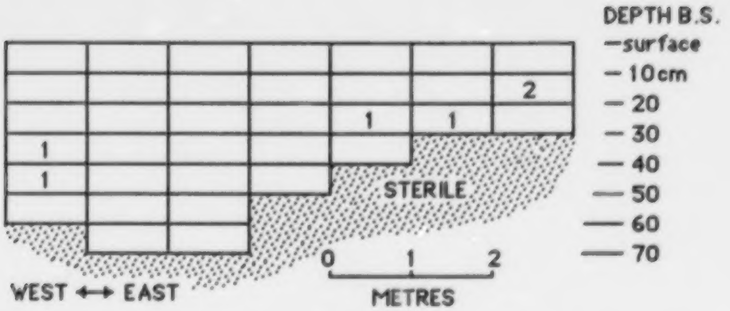


Figure 93. Distribution of Besant "Type 1" points by level in the block excavation at DkPj-1.

and h). None is complete; all are broken distal to the shoulders. Two of these are made of pebble chert, two of silicified mudstone, one of a dendritic gold chert, and the last of silicified limestone. Edge grinding is well developed on the lateral stem margins but not on the base. Otherwise, grinding can be described as light on all but the gold chert specimen which has been heavily ground on all margins proximal to the shoulder.

The shoulders of four specimens have been reworked subsequent to the formation of the notches, resulting in reprofiling of the blades. Such retouch may indicate a repair of a point which had lost its tip or sharpness, perhaps while the point was still hafted. This retouch has produced a rounded, obtuse-angled aspect to the shoulder and a broader notch opening. As both attributes were criteria for classifying these two specimens as Besant points, classification may have been different had the original shoulder morphology been preserved. It would not be hard to envision a Pelican Lake projectile point of the morphology similar to the Mortlach Phase specimens described by Reeves (1983b:331) undergoing such a transformation. This caution is not limited to these specimens; any reusable point fragment could be reworked into a form typologically quite dissimilar to the original (Flenniken and Wilke 1989).

Four of the Type 2 Besant points were recovered in the contiguous block excavation (Figure 94) and one from each of the well-head excavation and the spring channel. The one pebble chert specimen from level 2 in unit 41 appears to be out of context. This specimen (no. 61469) exhibits poorer workmanship than the other specimens and may actually represent a different type.

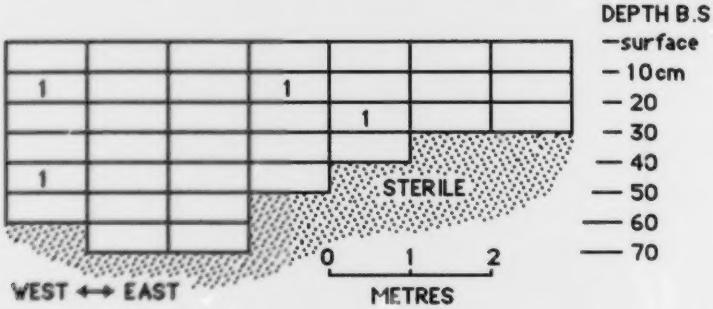


Figure 94. Distribution of Besant "Type 2" points by level in block excavation.

Pelican Lake Projectile Points (n=2)

These two specimens are heavily ground base fragments with sharp, acute-angled basal corners (Figures 80g and 81i). One specimen is truncated at the neck, and the other is broken obliquely retaining one remnant, sharp shoulder. The latter specimen (no. 68441; Figure 80g), the smaller of the two, is made of silicified mudstone and has parabolic corner notching and a convex base. The other specimen (no. 61033; Figure 81i) is made of Swan River chert and has a broader, slightly convex base. The provenience of these lends no assistance in interpreting their respective ages, since one was recovered from the spring channel and the other from the extreme east end of the block excavation, in the area of compressed and possibly disturbed stratigraphy.

Pinto/Elko Eared Projectile Point (n=1)

This unusual specimen consists of only the extreme proximal end of a well-made, eared dart point (no. 75466; Figure 80a). The original artifact apparently was quite thick, as the distal edge of this fragment, which must have been just proximal to the neck, is 5 mm in thickness. This specimen is made of a fine, mottled, red and yellow chert with the very greasy lustre characteristic of thermal pretreatment. The basal ears expand slightly, to form well-rounded, proximally trending ears separated by a notched base. Basal thinning is absent, except for the short, deep scars required to notch the base. Edge grinding occurs on the stem margins but not on the inside of the notch. This specimen looks very similar to the Pinto Barbed or Elko

Eared specimens more typical of the Great Basin, such as those illustrated by Butler (1970), which date to roughly between 1,400 and 3,300 years B.P.

The artifact is separated from its distal end by a fracture that initiates transversely from one lateral stem edge. Enough force was applied to leave pronounced compression ripples on the fracture surface. Such an application of force at this location likely was more intentional than accidental. It is possible that this specimen had been truncated basally to facilitate later reworking by a craftsman in need of some good raw material, and, thus, it was removed from from its original context. This specimen was found in level 3 of the stratified section in a context dated to approximately 800 years B.P., a late context for this type if it has been correctly identified.

Northern Side-notched/Bitterroot Projectile Points (n=2)

These two specimens have dimensions presumed to be indicative of dart point size. Both are completely bifacially retouched, have very slightly concave bases and approximately square shoulders, and were broken across the blade by means of impact fractures (Figures 80b and 81c). Basal thinning is well executed on both specimens, with thinning scars terminating at a small step fracture just above the shoulders on one face and extending to the neck on the other face. Basal grinding is not well developed on either specimen. The shallow notches are directed from the sides, and each specimen has one parabolic and one U-shaped notch. The relative size of shoulders and the bases are approximately equal, with the base slightly wider on the larger specimen (no. 61001; Figure 81c) and slightly smaller on the other (no. 70481; Figure 80b). The notches on both are separated from the base by straight proximal lateral edges that contract very slightly towards the base, giving the stem the appearance of having square basal tabs. The larger specimen is made of Swan River chert and was recovered in the spring channel excavations; the other is made of a dull, brown chert and was recovered from level 2 at the east end of the block excavation.

Oxbow/Lewis Projectile Points (n=2)

These specimens are morphologically quite similar. Both have shallow, V-shaped bases and broad, shallow, parabolic side notches that expand proximally to form angular, obliquely oriented "ears" (Figure 81d and e). One ear is broken on each specimen. The short edges that separate the notches from the bases are straight and contract proximally. The widest point is at the shoulders, which are obtusely angled on one and somewhat rounded on the other. All the margins proximal to the shoulders have been ground. The smaller specimen (no. 61006; Figure 81e) is made of a vitreous grey quartzite and is completely bifacially flaked. The larger specimen (no. 61031; Figure 81d) is made of a lightly patinated brown chert and has part of a ventral flake surface present as most of one face. One lateral margin of this specimen has been broken from the base up to and including the tip. These specimens are very similar to Oxbow projectile points; however, the dimensions, and particularly the angularity of the basal ears, more closely resemble the Lewis type described by Wheeler as "Early stage Middle Prehistoric" affinity (1985:7). Both points were recovered from the spring channel excavations.

Unnotched Lanceolate Projectile Points (n=3)

These specimens all lack lateral notching and basal grinding and are completely bifacially flaked. All three are considered different types. The smallest specimen (no. 66542; Figure 81a) is made of Swan River chert. It is basally notched, with a small, remnant, proximally trending ear. The opposing corner is broken. The one complete blade edge is convex.

The largest specimen is composed of two refit pieces (nos. 65435 and 65703; Figure 81b) which were recovered from two stratigraphic levels in the same unit of provenience (Figure 95). The fracture which separated the two halves was a heat-induced fracture that followed a flaw in the rock. This specimen has a triangular form and is of the size range of a dart point. The base is shallowly concave and forms a sharp, acute-angled, proximally trending juncture with the slightly convex blade edge. One corner of the base is missing; it has been truncated on an oblique fracture. Basal thinning is well developed and extends to approximately the midpoint from along most of the inside edge of either side of the base. No basal grinding is apparent.

Stylistically, this larger specimen, although relatively short, resembles certain styles of Early Prehistoric projectile points, such as the Meserve type. Such an early style is unprecedented at the HSI processing area, although Scottsbluff material was recovered elsewhere on site by Wettlaufer (1949). An alternate and more plausible interpretation is that this specimen is an unnotched preform of a dart point. The larger "Northern Side-notched/Bitterroot" specimen described above, also is made of Swan River chert and is morphologically very similar, save for the side notches. Both have identical widths and thicknesses, although the notched specimen would have been a bit longer.

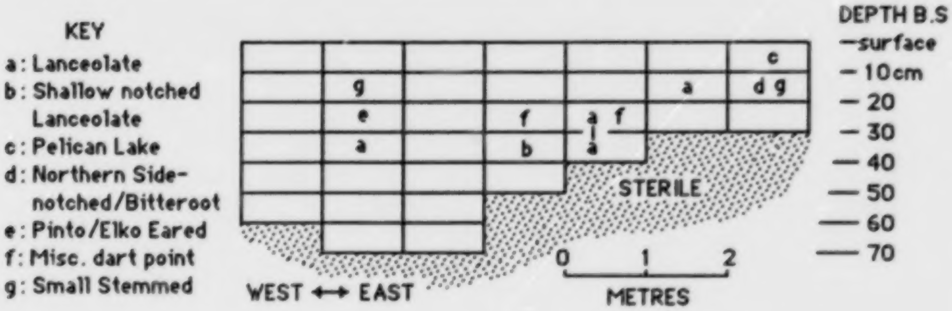


Figure 95. Distribution of other projectile points by level in the block excavation at DkPj-1.

The last of the three points (no. 75732), a badly potlidded, vitreous chert specimen, is quite thick, almost 6 mm. The base is very slightly convex and forms an angular juncture with the blade edge. Basal thinning occurs as a few, shallow, broad, parallel-sided flake scars which, on one face, extend to the irregular transverse fracture that broke this specimen. This latter fracture has exposed a flaw in the rock, and it appears that this may have contributed to the breakage of the specimen before the thermal destruction occurred.

Shallow Notched Lanceolate Projectile Point (n=1)

This obsidian artifact (no. 65119; Figure 80f) is presumed to be a dart point. The tip has been snapped transversely through the blade, revealing a very symmetrical, biconvex cross section. The workmanship on the specimen is excellent, with horizontal, parallel-sided to expanding flake scars which, in some cases, extend completely across either face. An "incipient" stem has been fashioned by producing two very shallow and broad side notches with alternate unifacial retouch positioned close to the base. The lower notch edge expands proximally to form acute angled junctures with the base. One of the notch edges is broken. The base is very even and very slightly concave, and it has been heavily ground, as are the notch and stem edges. This specimen was recovered from the eastern edge of the stratified area in the block excavation below the sterile sand horizon (Figure 95).

Miscellaneous Dart Points (n=4)

Two of these specimens (nos. 61962 and 63444; Figure 95) are quite similar and were found about one metre apart in the east end of the block excavation. Both are base fragments, with slightly convex bases and rounded corners leading to broad side or corner notches. Both exhibit light basal grinding. The broader specimen is made of a silicified mudstone flake; the other is made of porcellanite and is extensively flaked over what remains of the original surface. These two specimens may be bases of either Type 2 Besant points, as described above, or Pelican Lake types.

The third specimen (no. 71592) was found on the surface, adjacent to the block excavation, and consists of a single, large, acute-angled shoulder made from a marginally retouched piece of porcellanite. The notch must have been directed from the corner and would have exceeded 8 mm in depth. No cultural affinity has been assigned this artifact.

The last specimen (no. 71957) was recovered from the well-head excavation. This completely bifacially flaked, Swan River chert artifact has small, U-shaped notches directed inwards from the side so close to the base that no proximal lateral edge was formed (Figure 81j). The base is convex and forms a small, laterally projecting juncture at the one remaining corner. No basal grinding is evident. The shoulders are approximately square and blunt.

Unidentifiable Point Fragments (n=95)

These are unclassifiable fragments, representing tips (34), midsections (16), points missing bases (15), base fragments (9), lateral segments (7), bases (9), or small pieces which could not be oriented (5). Most appear to be arrowhead fragments, although some may be dart point fragments. Four fragments were recovered from the spring channel; the remainder are from the processing area - one of these was recovered from the well-head excavation.

Included in this sample are two tips and a base made of Kootenay argillite. Reeves (1983a:124D) has suggested that this material was most common during the Pelican Lake Phase at HSI. The fragmentary nature of the Kootenay argillite specimens prohibits evaluation of this observation based on typology alone. One of the tips was recovered from the spring channel; the other two specimens were recovered from level 2 in the west and east ends of the the block excavation. The specimen from the east end (no. 67360) is a shallow, side-notched point base fragment with a slightly concave base.

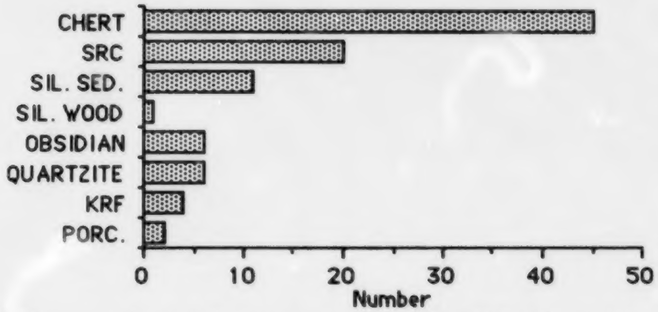


Figure 96. Raw material frequency of unidentifiable point fragments.

Hafted Knives (n=19)

The morphology of specimens in this category suggests that they do not have the symmetry or the dimensions suitable for use as projectile points; however, they all feature a hafting modification, either lateral notches or a stem demarcated by basal grinding (e.g., Figure 97k). Seventeen specimens are bifacially formed, and two exhibit marginal retouch. Cortex has been completely removed on most specimens; the mean cortex value is 0.29. All are basal fragments. No values were obtained for edge angles because the working edges are missing or incomplete. The principle raw material types represented are Swan River chert (8-42.1%) and quartzite (5-26.3%).

One Swan River chert specimen looks somewhat like a stubby Oxbow type point. One lateral margin is a longitudinally trending, flat surface which makes one side very thick, giving this artifact a wedge-shaped cross

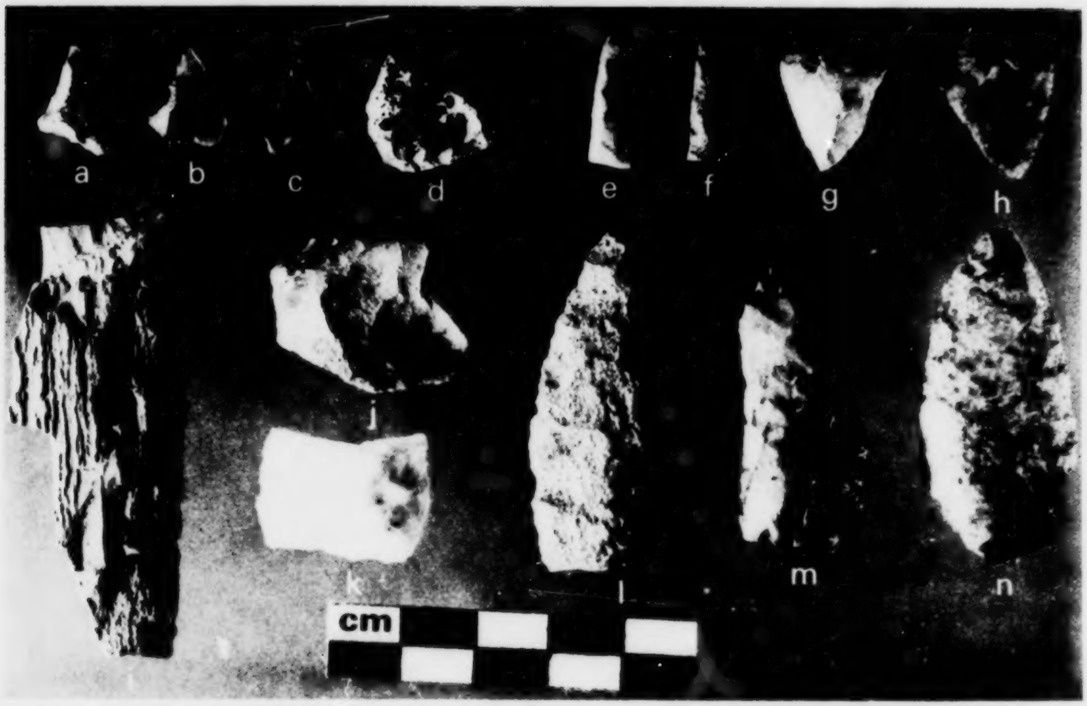


Figure 97. Flaked Stone Tools - Triangular flake tool: a; awl/borers: b, c; spokeshave: d; drills: e, f; endscrapers: g, h; bifacially retouched MURL: i; sidescraper: j; preform/hafted knife: k; knives: l-n.

section. Numerous attempts at thinning this spot apparently failed. Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	3.2	0.1	13.9	3.7
Length	26.9	15.1	39.9	8.6
Width	19.1	9.7	26.0	6.1
Thickness	7.2	4.4	10.3	2.3

Knives (n=34)

These artifacts have bifacially retouched, straight to mildly convex, acute-angled edges which extend around most of the periphery (e.g., Figures 97l-n, 98a and b and 99a). Retouch is extensive on all but two; cortex is largely absent (cortex value = 0.21). As a result of the extensive retouch, blank characteristics have been obliterated; although, one specimen appears to have been formed from a bipolar spall. Swan River

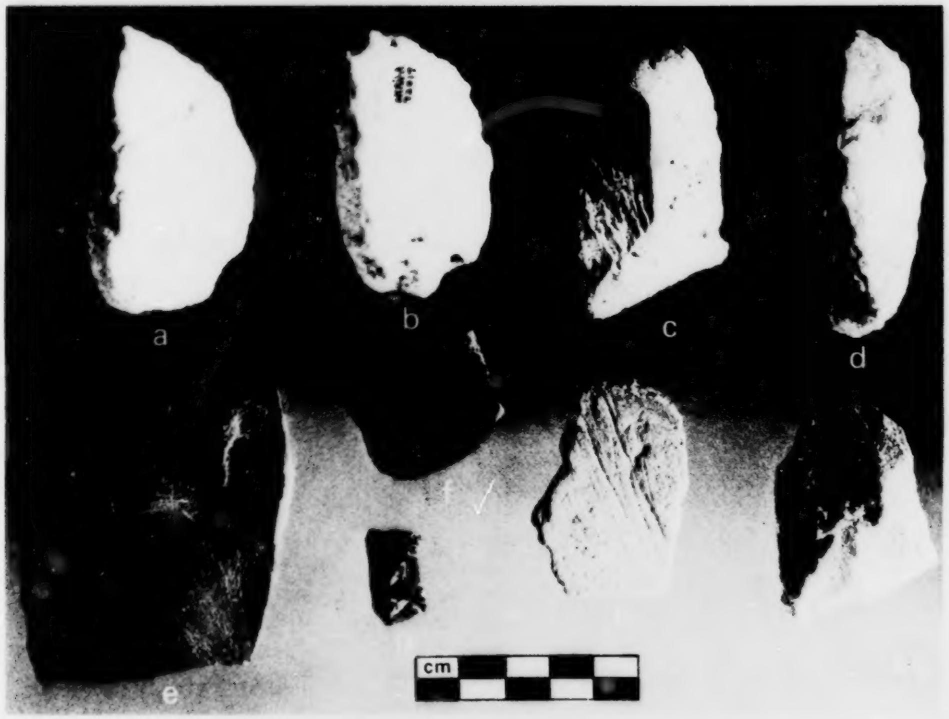


Figure 98. Flaked Stone Tools and Cores - knives: a, b; sidescrapers: c, d; bifacially retouched and etched slate slab: e; bipolar cores: f, g; etched siltstone slab: h; wedge: i.

chert (10; 29.4%) and quartzite (9; 26.4%) dominate this tool category. Both of these materials are well suited to cutting tasks, as they tend to be tough and durable. Twelve of the artifacts are complete; otherwise, they are represented by ends (15) or midsections (7). Outline morphologies are highly variable but usually are ovate to elliptical.

Two forms may represent discrete morphological subtypes. The first of these (type "A") consists of two complete Swan River chert artifacts (nos. 61026 and 72017; Figure 98a and b, respectively). Both have asymmetrically skewed, ovate outlines and asymmetrically biconvex to plano convex cross sections. One end of each specimen is broadly convex; the other end tapers - to a rather sharp tip on one specimen. Both are completely bifacially flaked. The straight, lateral edge has been steeply flaked to form a single-bevelled edge with a 65-70° angle, apparently for scraping tasks or for backing. The opposite convex edge has a uniformly double-bevelled cutting edge in the range of 45-50°. One of these was

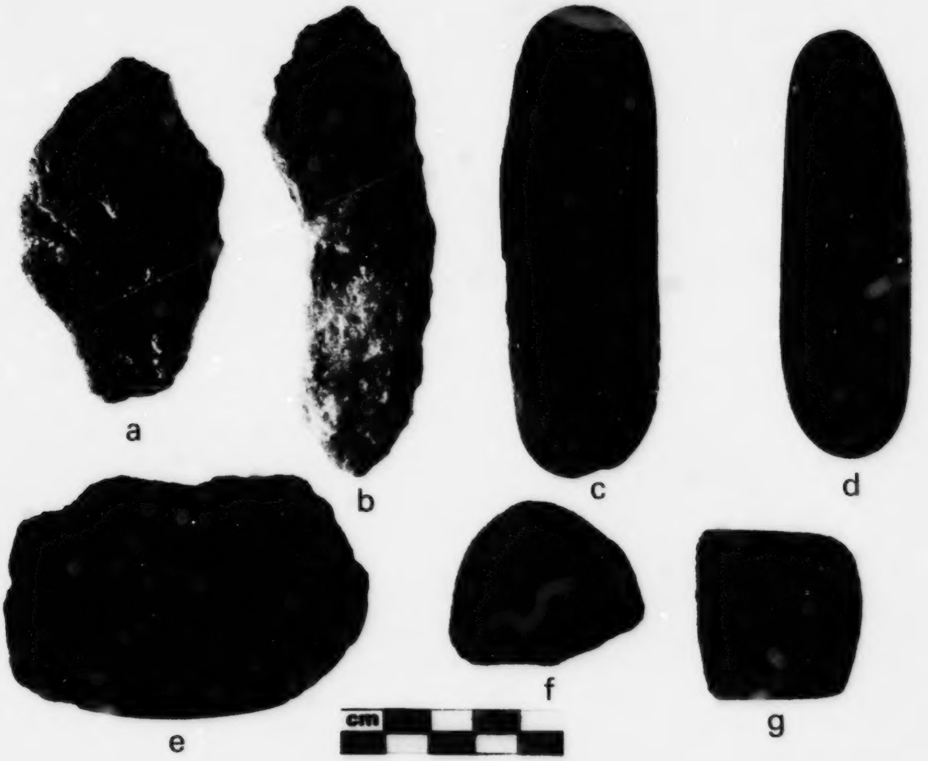


Figure 99. Stone Tools - knife: a; sidescraper: b; sausage-shaped hammerstones: c, d; edge ground flake: e; grooved arrow shaft smoothener: f; tabular stone abrader: g.

recovered from the spring channel tests and the other from a depth of 40 cm in the well trench excavation (unit 43).

Type "B" is represented by four broken, asymmetrical specimens (nos. 61077, 67509, 71858 [Figure 97l] and 75284 [Figure 97m]). All have a thick, biconvex cross section and a very narrow outline. One lateral edge is straight to slightly concave, and the opposite lateral edge is mildly convex. These edges contract to form blunt ends. All have been transversely snapped near the midpoint, removing the opposite end. Two specimens are made of chert; one is porcellanite; and the other is quartzite. All four specimens were recovered from the top 20 cm of the processing area. Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	16.2	0.2	67.6	17.8
Length	41.9	22.0	81.2	15.8
Width	26.3	13.3	45.6	8.5
Thickness	10.3	4.9	21.5	3.8

Preforms/Hafted Knives (n=4)

These have square, thinned bases and transversely fractured blades. The symmetry and dimensions suggest that these artifacts were suitable for use as hafted knives or projectile points, but the impression is that they are not finished, since they lack both lateral notches and basal grinding. All are extensively bifacially flaked and are made of chert, including two of Swan River chert, one of Madison Formation chert and one of Top-of-the-World chert (Figure 97k). Cortex has been completely removed, and no blank characteristics are evident. Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	2.5	1.8	3.2	0.6
Length	21.3	18.8	23.1	1.8
Width	18.1	14.9	20.8	2.6
Thickness	5.8	4.5	6.3	0.8

Awls/Borers (n=7)

Although wear was not observed on any of these specimens, all have attributes suggestive of use as piercing tools (e.g., Figures 97b and c and 100a and b). Three different styles are present. The first consists of broken, pointed projections, asymmetrically triangular in form and bifacially flaked. The second style comprises two flakes which have been bifacially flaked to form a very narrow projection. The distal tip has broken off both specimens. The third style is composed of two complete artifacts. Both are small, ovate, KRF flakes that have been marginally unifacially retouched to form very sharp tips. Basic metric attributes of these artifacts are as follows:

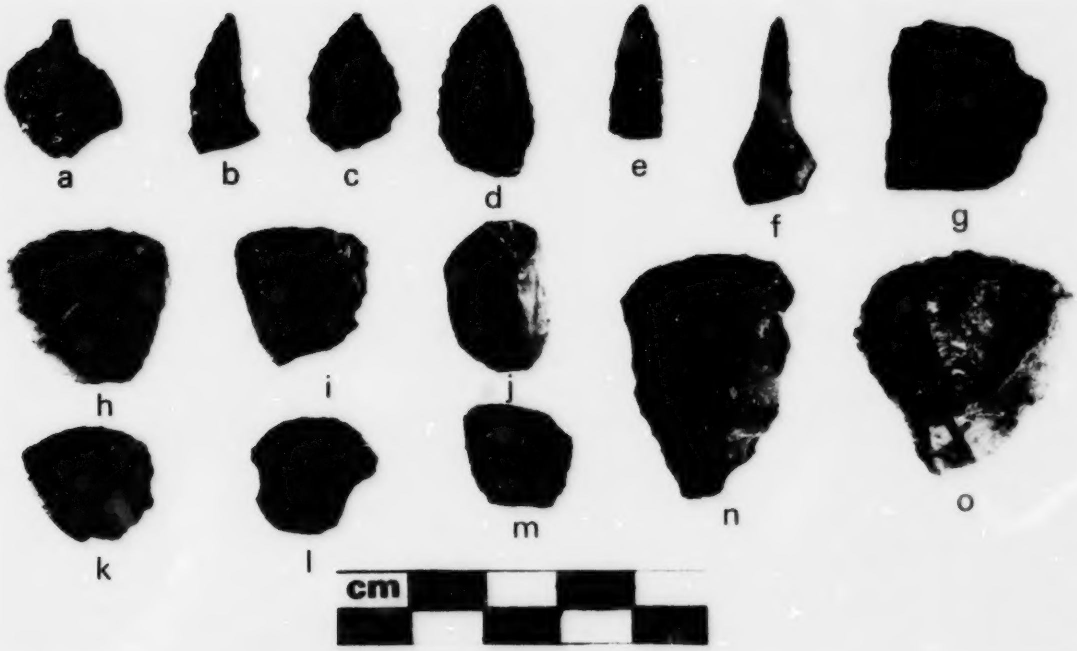


Figure 100. Flaked Stone Tools - awl/borers: a, b; triangular flake tools: c, d; drills: e, f; wedge: g; endscrapers: h-o. Note endscraper j has been split by bilateral, bipolar impact, removing the proximal end; view is of ventral face with bit at left.

	MEAN	MIN	MAX	STDEV
Weight	0.3	0.1	0.9	0.3
Length	16.2	11.4	20.8	3.5
Width	10.6	7.2	18.0	3.6
Thickness	2.5	1.4	4.5	1.0

Choppers (n=33)

These are relatively large, heavy tools characterized by a minimum of modification and one steeply angled edge that is crushed from use. Most have a cortex surface (cortex value = 2.0), often on the margin opposite the utilized end. Typically, these are either fist-sized cobbles with a few large flakes removed from one end, spalls, or thick decortication flakes of coarse-textured local materials. Two of the cobble choppers were probably simple single platform cobble cores before they were pressed into service as choppers. Like many of the big pieces of stone found on site, several of these choppers show signs of secondary use. Five have pitting attributed to use as anvils, and three are riddled with crenelated fractures indicating that they were subsequently used as boiling stones. Quartzite is the most prevalent raw material used (18; 54.6%), and argillite (7; 21.2%) is well represented also. Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	351.2	53.8	916.2	225.4
Length	113.1	40.5	406.7	63.0
Width	75.9	37.8	122.0	19.5
Thickness	32.6	13.0	71.6	11.8

Drills (n=4)

Four artifacts are classified as drills (Figures 97e and f and 100e and f). Three of these are drill "bits" only. All appear to be made of exotic chert, are bifacially retouched and lack cortex.

The one complete specimen (Figure 100f) is a flake butt drill made by retouching the distal end of a thin flake to a narrow bit tapering evenly to a pointed distal tip. The platform of the flake blank is preserved as the proximal end of the butt. The cross section of the bit is diamond shaped and the maximum bit width is 5.0 mm.

One bit fragment (Figure 100e) is broader than that of the other three drills and probably represents only the distal end of a relatively large specimen. It too has a diamond-shaped cross section, with a maximum bit width of 7.5 mm.. The sides of this specimen are nearly parallel, but they converge distally to form a sharp tip.

The two remaining drill bits (Figure 100e and f) are nearly identical in dimensions and morphology. Both display excellent workmanship. Both are nearly parallel sided with straight, even edges and uniformly thick biconvex cross sections. The transverse snap fracture which broke these specimens appears to have occurred at or very near the juncture with the butt. The maximum bit width at this location is 6.0 and 6.3 mm. The distal end of one specimen is formed into a diminutive transverse edge; the distal extreme of the other specimen has been snapped off. Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	0.4	0.3	0.6	0.2
Length	19.3	16.5	25.2	4.0
Width	7.8	5.8	11.5	2.5
Thickness	2.9	2.5	3.4	0.4
Angle	56.3	50	65	6.3

Edge Ground Flakes (n=10)

These are all thick spalls or decortication flakes (cortex value=1.4) which characteristically have one utilized, lateral edge (e.g., Figure 99). The wear on these tools occurs as a flat facet extending for most or all of the length of one evenly straight to convex and relatively steeply angled margin (mean angle=56°). The wear facets have longitudinally trending striations which indicate that these artifacts were used in a sawing motion. On two specimens, the ventral face is smoothened, but otherwise there is no modification or retouch present. With the exception of one small, silicified mudstone flake, all are quite large. Other than for this small specimen, the raw materials used are coarse, including quartzite (3), argillite (2), siltstone (1), sandstone (1) and two unidentified coarse-grained metamorphics. It is not known if these materials exclusively were selected for the task that resulted in this distinctive type of wear or if a broader range of raw materials were similarly used but do not acquire the type of wear seen on the coarse materials. Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	119.9	1.8	260.9	84.3
Length	75.7	21.0	120.1	27.0
Width	58.0	16.6	93.4	19.8
Thickness	21.2	5.8	34.8	10.0

Endscrapers (n=67)

This category consists of artifacts whose working edge forms a single, bevelled, evenly convex edge set transversely to the longitudinal axis of the tool (e.g., Figures 97g and h and 100h-o). In most cases, this morphology was achieved with either extensive unifacial flaking of the tool blank (n=34) or marginal unifacial retouch of one end (n=32). In one instance, the tool was completely bifacially flaked (Figure 100n).

Most of the endscrapers in this assemblage have attributes indicating that they were derived from bipolar split pebble fragments (n=34; Figure 100k-m). Otherwise, where the blank attributes were not obscured by retouch, they are made typically on expanding flakes with retouch on the dorsal face of the distal flake edge. The tendency to use bipolar core by-products in the manufacture of endscrapers is not surprising. Small spalls, such as those derived by the bipolar reduction of a pebble, often already have a plano convex cross section which can be readily modified into a single, bevelled edge. Cortex surfaces are common (cortex value=0.82), and where present, they invariably occur on the dorsal faces of the tools. At least six of the endscrapers which were derived from bipolar split pebble cherts have a particularly greasy lustre on all fracture surfaces. This suggests that these specimens were thermally pretreated in pebble form prior to splitting.

Virtually all of the endscrapers appear to be worn out or broken. Stepped, overhanging edges on some specimens indicate failed attempts at rejuvenation. Most of the broken specimens were broken on a transverse snap fracture just proximal to the bit (n=12). Less frequently, the artifacts were split longitudinally, bisecting the bit (n=3). Three endscrapers were extensively potlidded from heat damage; in one case, this removed most of the dorsal face. Endscrapers are particularly prone to such thermal damage, as thick, fine-grained artifacts tend to be radically affected by differential expansion when heated.

Chert was the favorite lithic medium for the manufacture of endscrapers (48; 71.6%). Silicified sediment accounted for more than half of the remainder (11; 16.4%). Of the silicified sediments, only the mudstone grade was used for endscrapers. This bias towards the mudstone texture is not reflected in the other tool categories. Apparently, the slightly more grainy textures of silicified siltstone and silicified sandstone were less desirable, either for the scraping task or for the ease of manufacture and rejuvenation of endscrapers.

Three especially thick chert specimens were broken by bipolar reduction subsequent to their use as endscrapers (e.g., Figure 100j). This practice of further reducing exhausted tools of good quality material is not uncommon at HSI and is likely due to the lack of fine-grained, isotropic, lithic material in the site vicinity. Bipolar reduction is the most effective means of deriving useful by-products from such small pieces. Metric attributes of the endscraper assemblage are as follows:

	MEAN	MIN	MAX	STDEV
Weight	2.1	0.3	6.7	1.2
Length	18.1	7.7	32.6	4.6
Width	17.4	6.7	29.4	3.5
Thickness	5.6	3.0	9.7	1.5
Angle	70.7	55	90	6.4

Sidescrapers (n=46)

These artifacts bear one or more unifacially retouched, working edges which are straight to convex in form (e.g., Figures 98c and d and 99b). Retouch on two narrow, formed, quartzite specimens extends around the entire periphery (e.g., Figure 98d). Otherwise, retouch is restricted to a single, lateral edge (39) or both a lateral and an adjacent transverse edge (5). In most cases, retouch is limited to the margins (41), with extensive dorsal flaking present on the remainder (5). Three specimens were formed on bipolar ,split pebble fragments; the others were made on flank blanks of highly variable morphology. Most tend to be relatively thin, with a plano convex to triangular cross section. A small remnant cortex surface on the dorsal face is quite common (cortex value=0.67). The integrity of these specimens is difficult to evaluate since many broken flakes served as blanks for these tools and retouch may have been imparted either before or after breakage. The principle raw materials used for the sidescrapers are chert (19; 41.3%), quartzite (10; 21.7%) and silicified sediments (8; 17.4%). Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	16.0	0.3	106.6	27.5
Length	37.0	16.6	109.2	23.6
Width	24.4	10.9	62.8	11.7
Thickness	7.7	2.1	19.8	4.6
Angle	63.6	40	85	10.13

Spokeshaves (n=26)

These are similar to sidescrapers except that the working edge is concave rather than straight or convex (e.g., Figure 97d). None is extensively modified; rather, the specimens exhibit use retouch on the dorsal face, apparently from scraping a hard surface with one (18) or two (8) working edges. Fourteen are made on secondary decortication flakes or spalls, including three derived from bipolar reduction; the remainder were were made on thinning flakes. The mean cortex value is 0.77. The majority of the spokeshaves were made from chert (9; 34.7%) or silicified sediments (9; 34.7%). These two materials are well represented in the sidescraper category as well. There is only one quartzite spokeshave (3.8%) whereas almost a quarter (22.2%) of the sidescrapers were made of this material. It may be that quartzite is more resistant to wear, which would result in a concave edge, but it seems more likely that this discrepancy is functional. Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	4.1	0.3	23.5	5.9
Length	28.0	14.7	56.8	10.3
Width	18.3	12.1	38.1	7.0
Thickness	5.7	2.3	13.6	2.7

Miscellaneous Uniface Fragments (n=25)

This heterogeneous category consists of fragments of unifacially formed artifacts that cannot be readily classified into any other morphological or functional category. All are small end or edge sections of larger tools. On some particularly convex specimens, it is impossible to determine the edge orientation. All are made on flakes; only one retains a cortex surface. Retouch invariably occurs onto the dorsal face. Four have attributes associated with bipolar reduction. Chert is the dominant raw material (21; 84%). Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	0.7	0.2	1.5	0.4
Length	15.0	10.8	23.7	3.6

Width	10.0	4.9	16.4	3.0
Thickness	4.6	2.4	11.5	2.1

Small, Triangular Flake Tools (n=23)

These are triangular to ovate in outline and typically asymmetrical (e.g., Figures 97a and 100c and d). Most are plano convex or asymmetrical biconvex in cross section. The majority are extensively bifacially retouched (n=14); the remainder are either marginally retouched (n=5) or unifacially flaked (n=4). Cortex and other blank characteristics have been removed from most (cortex value=0.18), but at least two bear attributes associated with bipolar reduction. Although some of these artifacts have projectile point or point preform characteristics, some dimension or parameter is regarded as too irregular to permit use as or formation into projectile points. A few may be preform rejects, but the plano convex cross section of most suggests that the artifacts are in their finished form. Four specimens have snapped off distal tips, but otherwise no wear is obvious. Such an artifact might be suitable for a variety of functions, such as cutting, scraping, graving or boring; however, this is speculative. Most are made of chert (14; 60.9%), or Swan River chert (5; 21.7%); there are two specimens each of porcellanite and silicified sediment. Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	0.9	0.1	2.0	0.6
Length	17.9	12.4	23.3	3.5
Width	12.8	8.3	17.2	2.6
Thickness	4.0	2.2	7.0	1.3

Wedges (n=5)

These artifacts (e.g., Figures 98i and 100g) are synonymous with the pièces esquillées described in our two previous reports (Brink *et al.* 1985, 1986) . The use of this latter term has been dropped to avoid the unnecessary confusion with bipolar technology surrounding this term (Hayden 1980).

The wedges recovered during the 1985 and 1986 field seasons have a quadrilateral outline. In two cases, this shape was obtained by retouching all four margins; two were formed by retouching two opposing margins; and one small, thick flake fragment was unmodified other than the crushing attributed to use. The cross sections are biconvex, with the exception of this latter specimen which had a "wedge-shaped" cross section. The utilized edges are blunt and crushed for their entire length. Tough rather than brittle materials were selected for this tool type, with silicified sediments (3), quartzite (1) and silicified wood (1) represented. Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	7.4	1.2	24.0	9.4
Length	30.2	20.5	45.8	10.0
Width	23.1	14.1	37.2	8.5
Thickness	8.5	6.0	14.4	3.5
Angle	55	45	65	7.9

Miscellaneous Biface Fragments (n=120)

This heterogeneous category consists of fragments of bifacially formed artifacts which cannot be readily classified into any other morphological or functional category. These fragments are pointed or rounded ends or points of juncture (54), sections of artifacts bearing part of one edge (50), or midsection fragments bearing portions of both edges (16). Some specimens may be portions of projectile points, but most appear to be parts of relatively small cutting tools or knives. All retouched edges are straight to convex. Retouch has removed most of the blank characteristics and cortex; the mean cortex value is only 0.02. Breakage of most specimens appears to be the result of use rather than manufacture or post-depositional factors; however, in 11 cases, breakage was due to exposure to heat. Two of these latter artifact fragments were assembled from two or more heat fractured pieces found in close proximity. The principle raw material types represented are chert (60; 50.0%), Swan River chert (17; 14.5%) and silicified sediments (15; 12.8%). Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	1.8	0.0	47.7	4.9
Length	17.1	1.3	42.0	6.7
Width	11.8	0.9	27.3	4.7
Thickness	5.1	0.5	16.0	2.5

Bifacially Retouched MURLs (n=103)

Typically, these are flakes or flake fragments that have one or more bifacially retouched margins, or they are portions of larger broken specimens which retain only a small section of a marginally bifacially retouched edge (e.g., Figures 97i and 98e). Their presumed function is to provide an expedient cutting or sawing edge. Few of these artifacts retain very much cortical surface (cortex value=0.48). Only four were manufactured from a bipolar flake blank.

One slate specimen displays evidence of secondary usage in the form of many fine, linear scratches etched onto both faces. It appears as if a sharp instrument was rubbed back and forth on a small, localized area on either face (Figure 98:e).

Significantly, the raw material best represented is silicified wood (53; 51.5%); chert is the next most common material (16; 15.5%). Silicified wood is difficult to flake as it tends to fracture along the grain into relatively flat pieces. This constraint reduces the likelihood that this material would be flaked extensively into formed artifacts. Although it often splits into tabular pieces, it is very suitable for providing blanks for thin tools, such as those that need only a minimum of modification to be useful. Apparently, the combination of toughness and fracture characteristics made this material an important contribution to the tool kit. Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	4.6	0.1	162.2	17.9
Length	21.9	8.8	124.2	14.8
Width	15.0	6.0	90.4	11.3
Thickness	4.5	1.2	13.1	2.3

Unifacially Retouched MURLs (n=52)

These are typically flakes or flake fragments that have small, discontinuous or irregular unidirectional, utilized margins, or they are portions of larger, broken specimens which retain only a small section of a unifacially retouched edge. Several retouched specimens, including one of obsidian, have alternate unifacial retouch. Where modification is due to use, it is in the form of minute, unifacial, scalar retouch from unidirectional use perpendicular to the edge. Many of these artifacts retain a portion of cortical surface (cortex value=0.62) and appear to represent all stages of the reduction process. At least six were derived from bipolar reduction. The raw materials best represented are chert (17; 32.7%), Swan River chert (11; 21.2%), quartzite (10; 19.2%) and silicified sediments (7; 13.5%). Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	5.3	0.1	94.6	13.8
Length	24.9	7.0	74.7	15.2
Width	17.0	6.1	65.3	10.0
Thickness	6.4	1.9	19.2	3.9

Bifacially and Unifacially Retouched MURLs (n=5)

Five artifacts are flakes or flake fragments that have a unifacially retouched edge and a bifacially retouched edge on opposing margins. The two modes of retouch represent multi-purpose tools, except for two obsidian specimens. On these, the unifacial flaking may represent a protective backing. Two of these artifacts, one Swan River chert specimen and a quartzite artifact, retain a portion of cortical surface. The raw materials represented are Swan River chert (2) obsidian (2), and quartzite (1). Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	2.5	0.4	9.1	3.7
Length	21.2	10.3	34.1	8.9
Width	16.2	10.2	25.8	5.8
Thickness	5.1	2.8	12.3	4.1

Utilized MURLs (n=113)

Typically, these are flakes or flake fragments of highly variable morphology that have small, discontinuous or irregular utilized margins which could not be classified into one of the above categories. Modification is due to use only and occurs in the form of minute, unifacial and/or bifacial nibbling retouch or edge smoothening. All stages of the reduction process are represented in this artifact class. Many of these artifacts, therefore, retain a portion of cortical surface (cortex value=1.12). At least 18 bear evidence of bipolar reduction. The raw materials best represented are chert (32; 28.3%), Swan River chert (23; 20.3%), quartzite (15; 13.3%), silicified sediments (13; 11.5%) and argillite (11; 9.7%). Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	20.2	0.1	415.1	56.8
Length	31.6	9.0	127.6	25.1
Width	23.0	4.4	102.8	19.1
Thickness	8.1	1.2	67.6	8.5

Miscellaneous MURLs (n=37)

Typically portions of larger broken flakes or flake fragments, these specimens retain only a small section of a marginally retouched or utilized edge. Breakage has often truncated the retouched or utilized edge, and only a residual edge section remains. No function or morphology could be determined for these artifacts. Many of these specimens retain a portion of cortical surface (cortex value=0.55) and appear to represent all stages of the reduction process. At least seven were derived from bipolar cores. The raw materials represented reflect the heterogeneous nature of this catch-all category. The bulk of the specimens are chert (15; 40.5%), silicified sediments (5; 13.5%), argillite (5; 13.5%), quartzite (4; 10.8%) or Swan River chert (4; 10.8%). Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	11.4	0.0	138.0	30.4
Length	23.8	8.8	87.7	19.9

Width	17.9	2.0	82.0	17.3
Thickness	7.1	1.3	28.4	6.6

Cores

All lineal measurements of cores were obtained with sliding calipers to the nearest millimetre. Weights were determined with a digital balance to the nearest tenth of a gram. As before, a cortex value was obtained based on the relative amount of cortical surface cover on the entire specimen. By definition, a core should not be completely covered with cortex (i.e., 100%). The cortex values presented below are an average of codes on a scale of 0 to 4 rather than an actual percentage. A core category with a relatively high cortex value, for example 2.3, would indicate a core type with typically more than half of the surface covered with cortex. A small value of 0.23 would indicate that most specimens lack cortex. A summary of the core categories described below and the raw material types represented in those categories is provided in Table 31.

Table 31. Frequencies of raw materials represented in core categories, DkPj-1.

	CORES OF EACH RAW MATERIAL TYPE (N)													
CORE CATEGORIES	CHERT	SRC	KRF	OBS.	PORC.	SIL.SED.	SIL. WD.	QUARTZ	QTZITE.	ARG.	NON.SIL	SANDST	M.CRSE	TOTAL
BIPOLAR	134	90	1	3		30	44	16	12	7	3	1		341
SIMPLE	1	2				1			10	15	4	2	1	36
AMORPHOUS	6	5						1	6	7	3	1		29
BIFACIAL									2					2
SPALL									1					1
TOTAL	141	97	1	3		31	44	17	31	29	10	4	1	409

	CORES OF EACH RAW MATERIAL TYPE (%)													
CORE CATEGORIES	CHERT	SRC	KRF	OBS.	PORC.	SIL.SED.	SIL. WD.	QUARTZ	QTZITE.	ARG.	NON.SIL	SANDST	M.CRSE	TOTAL
BIPOLAR	39.30	26.39	0.29	0.88		8.80	12.90	4.69	3.52	2.05	0.88	0.29		100.00
SIMPLE	2.78	5.55				2.78			27.78	41.67	11.11	5.55	2.78	100.00
AMORPHOUS	20.69	17.24						3.45	20.69	24.14	10.34	3.45		100.00
BIFACIAL									100.00					100.00
SPALL									100.00					100.00
TOTAL	34.47	23.72	0.24	0.73		7.58	10.76	4.16	7.58	7.09	2.44	0.98	0.24	100.00

Bipolar Cores (n=341)

Bipolar cores are pieces of stone which have been broken by means of impacting one end with some form of hammer while the opposing end is supported on an anvil (e.g., Figure 98f and g). The vast majority are pebbles which are difficult to reduce by other means, but cobbles and and small thick lumps of debitage or even tool fragments (i.e., Figures 98g and 100j) have also been observed to be reduced in this manner. Fracture is initiated both from the percussion delivered by the hammer and by the force rebounded from the anvil. Some bipolar cores show evidence of having been impacted several times with different axis orientations. Apparently, the first attempt did not produce a satisfactory result. A wide variety of resultant fracture patterns occur, but most often one or two telltale columnar fractures or broad scars with heavily undulating compression or "ripple" marks extend from one or both ends. The morphology is highly variable, with cores represented by core nuclei with little or no cortex remaining, lateral splinters, pebble halves or spalls, or truncated ends featuring one or more flake scars radiating from the apex. Bipolar by-products that did not exhibit either two opposing crushed platforms or a common impact point from which two or more flake scars radiate longitudinally were considered to be shatter. Because most of the bipolar cores were derived from pebbles, a residual cortex surface is usually present (cortex value=0.9). By far the most prevalent materials reduced by this technique at HSI are cherts, including 134 (39.3%) undifferentiated cherts and 90 (26.4%) specimens of SRC . Also well represented are silicified wood (44; 12.9%), pebbles of silicified sediments (30; 8.8%), and quartz (12; 4.7%). Several cobbles of quartzite (12; 3.5%) and argillite (7; 2.1%) were also reduced by this technique. Both the obsidian (3; e.g., Figure 98g) and KRF (1) specimens represent the attempted reduction of thick pieces of debitage or tool fragments rather than primary reduction. Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	6.7	0.2	354.3	22.1
Length	25.8	11.0	120.0	10.7
Width	16.9	4.0	76.0	7.6
Thickness	9.0	3.0	45.0	5.0

Only one of the bipolar cores was recovered from the spring channel. Of the 340 bipolar cores recovered from the processing area excavations, 174 were found in the stratified section of the block excavation. The majority (166; 95.4%) were recovered from above the sterile sand horizon in the top 30 cm of the deposit. Table 32 shows the vertical distribution of all cores from the stratified portion of the processing area by core types.

Table 32. Vertical distribution of cores recovered from the stratified section of the block excavation at DkPj-1.

	CORE TYPE			
LEVEL	Bipolar	Amorphous	Simple	Bifacial
1	39	2	2	1
2	80	7	7	
3	47	1	5	1
4	7	2	1	
5	1	2		

Simple Cobble Cores (n=36)

Simple cobble cores have flake scars all derived from a common platform with a common orientation (e.g., Figure 101d). By definition, the platform is a cortex surface, and the first flake detached would be a spall with cortex completely covering the dorsal face. The flake detachments typically occur at approximate right angles to the long axis of the cobble. Typically, cortex covers more than half of the specimen (cortex value= 2.6). The steeply angled edge is formed by the faceted surface, and the platform is often crushed, suggesting use as a chopping tool, and frequently a flat cortical surface on these cores has been pitted from use as an anvil (Figure 101d). Most of these cobbles are made of argillite (15; 41.7%) or quartzite (10; 27.8%). The sandstone simple cobble cores listed in Table 31 were recovered from the spring channel excavations near an outcrop of this material. Another 15 specimens were recovered from a stratified context in the block excavation (Table 32). Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX	STDEV
Weight	294.3	3.3	1081.9	217.3
Length	91.8	63.0	130.0	15.6
Width	69.4	39.0	108.0	15.8
Thickness	42.8	21.0	70.0	13.1

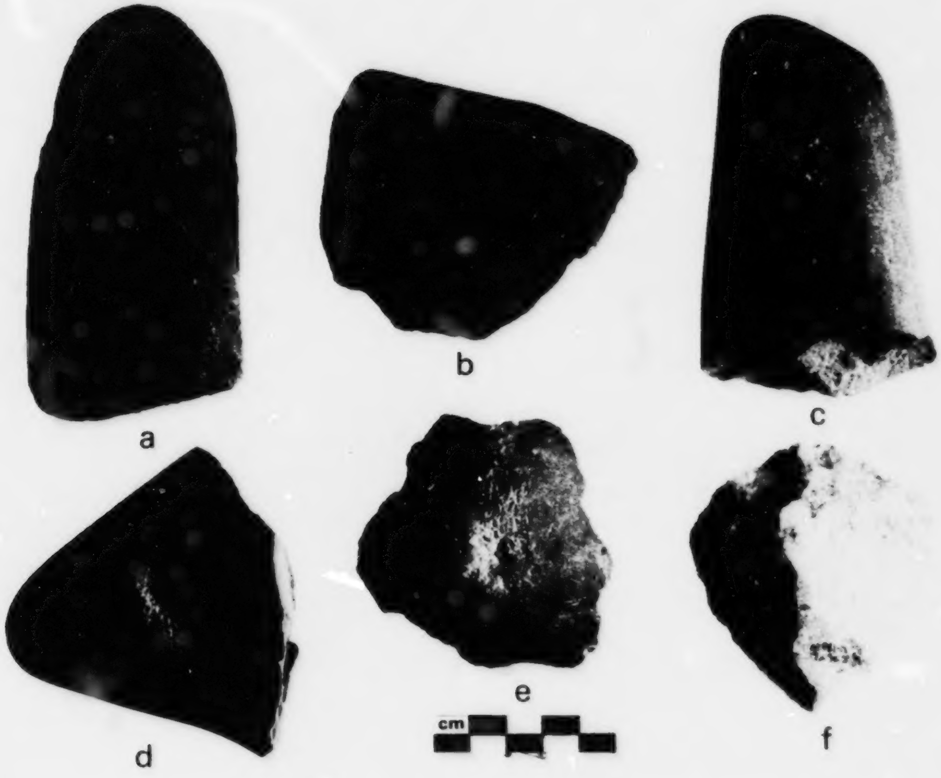


Figure 101. Stone Tools and Cores - cobble pestle: a; grooved abrader: b; hammerstone/anvil: c; simple cobble core: d; amorphous core: e; bifacial core: f. Note pecking from anvil use on specimens c, d and e.

Amorphous Cores (n=29)

These artifacts are multi-directional cores with two or more platforms and flake detachment orientations (e.g., Figure 101e). The cores apparently were rotated to take advantage of any likely platform. Both cortex surfaces and flake scar facets were utilized as platforms. Argillite is the most prevalent raw material utilized (7); quartzite and chert are represented by six specimens each; and five cores are SRC. Sixteen of these cores were recovered from a stratified context in the block excavation (Table 32). Basic metric attributes are as follows:

	MEAN	MIN	MAX	STDEV
Weight	249.4	10.0	1264.0	270.5
Length	74.4	34.0	150.0	30.5
Width	58.5	22.0	102.0	21.6
Thickness	34.5	12.0	96.0	18.9

Bifacial Cores (n=2)

These cores are reduced by flaking one face and using that face as the platform for reduction of the opposing face (e.g., Figure 101f). In both cases, the cores have been flipped several times to take advantage of both platforms. Both cores are quartzite, and both were recovered from the block excavation above the sterile sand lens (Table 32). Basic metric attributes of these artifacts are as follows:

Artifact no.	Weight	Length	Width	Thickness
76047	219.0	77.0	71.0	34.0
75583	35.3	46.0	40.0	22.0

Spall Core (n=1)

This quartzite specimen is a spall derived from a cobble by bipolar reduction. The flat fracture surface was used as a platform for removal of flakes from the dorsal face. This specimen was recovered from unit 43. Basic metric attributes are as follows:

Weight = 156.7; Length = 74.0; Width = 66.0; Thickness = 27.0

Debitage

A total of 15,523 pieces of debitage was recovered during the 1985 and 1986 field seasons at HSI. The distribution of these from within the various excavation areas is presented in Table 28.

Spring Channel Debitage

A list of the counts and total weights of debitage from the spring channel is provided in Table 33. This table reveals that the count of debitage is very low, the mean weight of debitage is relatively high, and the ratio of

Table 33. Summary of debitage recovered from the spring channel at DkPj-1.

RAW MATERIAL	COUNT	MEAN WT. (g)
Quartzite	17	11.6
Chert	9	0.68
Swan River chert	7	0.91
Silicified wood	2	1.3
Silicified sediment	2	4.6
Argillite	1	13.2

debitage to tools and cores (38 to 43) is also high. These observations are in strong contrast to the characteristics of debitage recovered from the processing area. We believe that the spring channel debitage is indeed quite different from that found on the prairie. It is possible, however, that small sample size and recovery bias are also responsible for some of the observed differences between the two assemblages. As discussed previously, the channel deposits were muddy or water-saturated, and dry screening was difficult. Small lithic items, typical of the processing area, could have been missed in the channel; however, we believe that if there had been very much small debitage in the channel sediments, more would have been recovered. Therefore, it is our conclusion that the debitage contained in the spring channel is generally larger in size and greatly reduced in frequency from that which typifies the processing area. The nearly equal debitage to tool ratio in the channel is also indicative of a general lack of either tool manufacture or tool maintenance activities carried out at the kill site area. This contrasts markedly with the pattern of the processing area debitage assemblage where these activities were well represented. It is apparent that the debitage from the channel is predominantly resharpening debris, struck from relatively large butchering tools, and that the manufacture of tools and the maintenance of small, formed tools were not important tasks at the kill site.

Processing Area Debitage

The analysis of lithic debitage recovered from previous excavations in the processing area (Brink *et al.* 1985, 1986) has indicated a remarkable similarity in this component of the assemblage despite the widespread nature of the excavations from which this material was obtained. Further analysis of the debitage recovered from the processing area in the 1985 and 1986 seasons was not expected to produce significant changes in our understanding of the debitage assemblage. With the recovery of debitage from the stratified area of the 1985 and 1986 excavations, however, we had the opportunity to evaluate if the acquisition of different raw materials, and the reduction strategies applied to these materials, underwent changes during the history of the site. For this reason, the focus of the debitage analysis has been on the 6,233 lithic items recovered from the stratified portion of the block excavation.

A summary of the counts and weights of the debitage of the various raw material types is presented in Table 34. For the purposes of this report, "flakes" are those pieces of debitage which retain a striking platform, while "shatter" refers to those which do not.

Table 34. Summary of debitage recovered from the stratified section of the processing area at DkPj-1 in 1985 and 1986.

	DEBITAGE COUNT			DEBITAGE WEIGHT (gm.)		
	SHATTER	FLAKES	TOTAL	SHATTER	FLAKES	TOTAL
CHERT	2315	1103	3418 (38.1%)	1167.6	722.0	1889.6 (6.5%)
SRC	1019	376	1395 (15.6%)	942.0	412.9	1354.9 (4.7%)
KRF	361	206	567 (6.3%)	156.9	114.2	271.1 (0.9%)
OBSIDIAN	194	78	272 (3.0%)	21.2	13.3	34.5 (0.1%)
PORCELLANITE	35	20	55 (0.6%)	6.7	3.7	10.4 (0.0%)
SIL. SEDIMENT	565	261	826 (9.2%)	378.6	193.2	571.8 (2.0%)
SIL. WOOD	307	45	352 (3.9%)	307.3	128.5	435.8 (1.5%)
QUARTZ	61	6	67 (0.8%)	49.3	4.0	53.3 (0.2%)
QUARTZITE	845	353	1198 (13.4%)	8467.9	6029.2	14497.1 (50.2%)
ARGILLITE	378	214	592 (6.6%)	2731.1	1770.5	4501.6 (15.6%)
NON. SIL. SED.	106	50	156 (1.7%)	1962.3	1606.2	3568.5 (12.3%)
SANDSTONE	32	17	49 (0.6%)	847.7	430.9	1278.6 (4.4%)
MISC. COARSE	15	5	20 (0.2%)	228.2	201.3	429.5 (1.5%)
TOTAL	6233	2734	8967 (100.0%)	17266.8	11629.9	28896.7 (100.0%)

The methodology used for the present debitage analysis was consistent with that used during the 1983 and 1984 seasons (Brink *et al.* 1985, 1986). The object of the analysis was to try to evaluate the overall reduction strategies applied to the specific raw materials and to identify any changes through time in the reduction strategies of those materials. A summary of the flake attributes of the debitage sample obtained from the stratified area is presented in Table 35.

Table 35. Summary of flake attributes recovered from the stratified section of the processing area at DkPj-1 in 1985 and 1986. (*One particularly aberrant 1,777 g quartzite flake was excluded from this sample.)

	N.	MEAN WT.(gm.)	M.WT. S.D.	MEAN SIZE	WT./ SIZE	DORSAL CORTEX	DORSAL SCARS	PLATFORM TYPE(%)		
								1	2	3
CHERT	1103	0.65	5.64	12.4	0.05	0.22	2.8	8.7	58.7	32.5
SRC	376	1.10	4.38	13.9	0.08	0.16	2.1	9.0	59.3	31.6
KRF	206	0.55	1.72	13.3	0.04	0.22	3.0	9.7	48.5	41.7
OBSIDIAN	78	0.17	0.35	10.5	0.02	0.05	3.2	0.0	64.1	35.9
PORCELLANITE	20	0.19	0.16	11.0	0.02	0.30	3.0	20.0	55.0	25.0
SIL. SEDIMENT	261	0.74	2.23	14.3	0.05	0.44	2.4	17.2	55.6	27.2
SIL. WOOD	45	2.86	15.57	14.8	0.19	0.95	2.6	20.0	57.8	22.2
QUARTZ	6	0.67	0.82	13.3	0.05	0.17	2.0	33.3	0.0	66.7
QUARTZITE	352*	12.08	38.25	25.4	0.67	0.50	1.8	46.7	42.2	11.0
ARGILLITE	214	8.27	16.53	26.7	0.31	0.64	1.8	68.2	27.1	4.7
NON. SIL. SED.	50	32.12	106.40	31.9	1.01	0.82	1.6	48.0	46.0	6.0
SANDSTONE	17	25.35	29.54	41.7	0.61	0.88	2.1	52.9	41.2	5.9
MISC. COARSE	5	40.26	83.84	40.0	1.01	0.80	2.0	100.0	0.0	0.0

Weights were measured to the nearest tenth of a gram using a digital balance. Weights which were less than 0.05 grams were rounded off to zero. Debitage was expediently "sized" rather than measured. A size value was obtained by placing the flake on a size chart on which squares were drawn with sides increasing by 5 mm increments. Thus, a size value of 35 indicates a flake which fits between the 30 and 35 mm increments when laid flat, or as flat as possible, on the chart. Ahler and Christensen (1983) have suggested that such size grading is useful for comparing large quantities of debitage. A ratio of flake weight to size is included in Table 35 as a indication of relative flake thickness. This assumes that the specific gravity, at least of the siliceous materials, is approximately constant.

The method of assessing the amount of cortex present on a specimen has been described earlier in this chapter. In the case of the debitage analysis, the cortex values apply to the dorsal flake surface only. The dorsal scar count is an actual count of scars observed on the dorsal face of the flake up to a maximum value of five. Three platform types are distinguished: (1) platforms that are composed of a cortex surface only, (2) platforms with a single flake scar facet, or (3) a multi-faceted platform.

In an analysis of experimentally derived debitage from known stages of reduction, Magne (1983) determined that the dorsal scar count and platform scar count were the most useful attributes for identifying various reduction stages and that weight alone was not a good index. Based on Magne's results, high values for dorsal scar count and platform scar count indicate a late stage of reduction. His study was based on reduction flakes larger than 5 mm, however. In our sample, much of the very tiny debitage, apparently the result of resharpening, has little more than a point for a platform. In addition, a large number of flakes appear to be derived from retouching unifaces, such as endscrapers. In these cases, a single faceted platform would not necessarily be indicative of the appropriate reduction stage.

Despite these concerns, it is apparent that there are significant differences between the debitage of the various raw materials. This is consistent with results obtained from the previous studies of the processing area debitage (Brink *et al.* 1985, 1986). In general, the debitage in our sample is dominated numerically by very small, thin, light weight debitage of fine-grained (often exotic) materials derived from the later stages of lithic reduction and tool maintenance. Complementing this fine-grained component of the assemblage are the more coarse-grained, local stones which represent the complete lithic reduction sequence. Some of these are of such poor quality that often they were rejected in the early stage of reduction and apparently were intended to provide only a very expedient use. Coarse materials are poorly represented numerically, but by weight they form the bulk of the assemblage.

An examination of the reduction characteristics of certain fine-grained and coarse raw materials recovered from the stratified portion of the processing area reveals few significant changes in reduction strategies through time. In Figure 102, the flake characteristics of dorsal scar count and dorsal cortex were compared between the five uppermost arbitrary levels. Coarse-textured raw materials with poor fracture characteristics which were not represented by all stages of the reduction process were not included in this analysis. These latter materials include

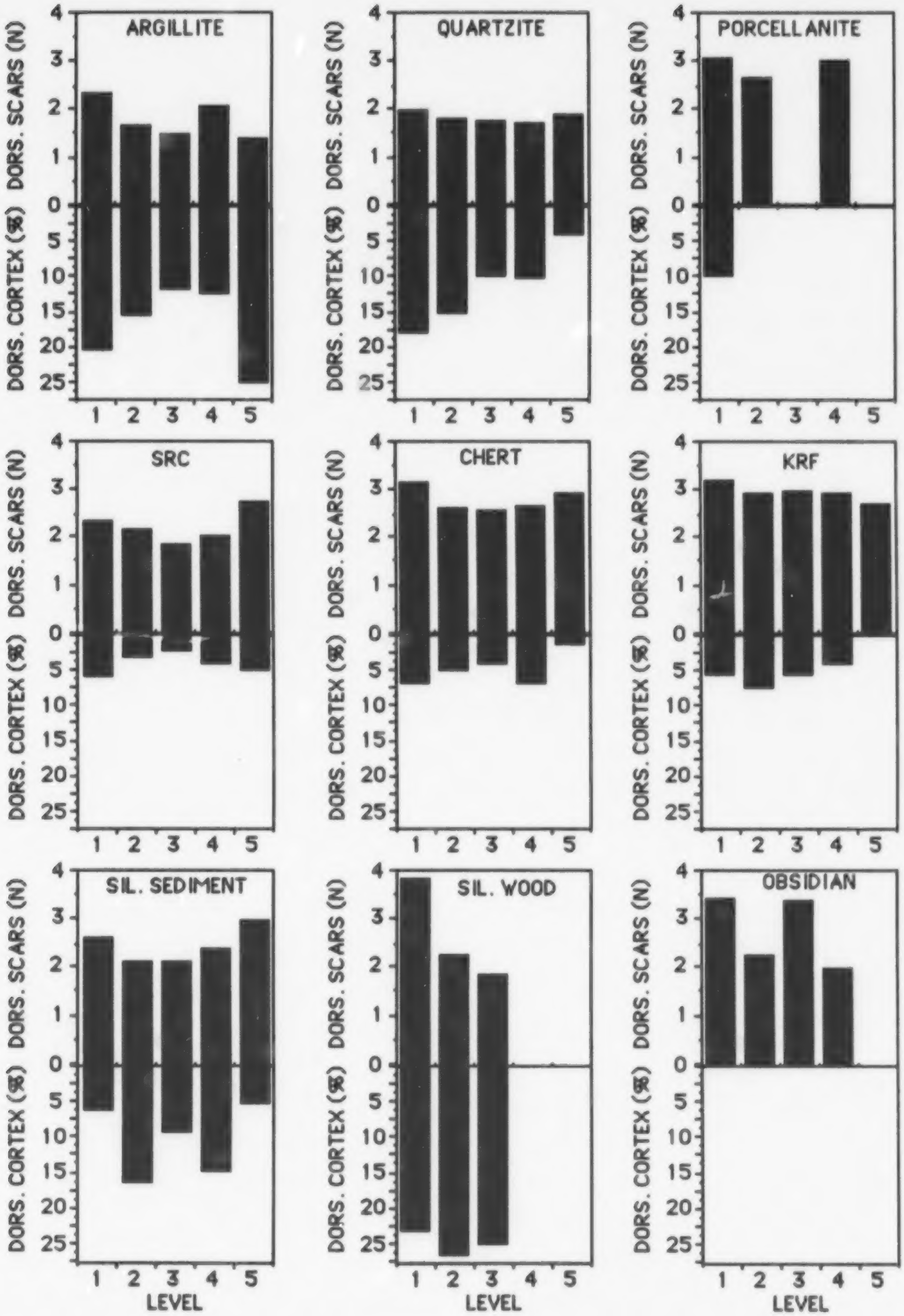


Figure 102. Dorsal cortex and scar counts on flakes from stratified area.

quartz, sandstone, non-silicified sediments and the miscellaneous coarse categories.

As expected, coarse materials tend to be characterized by a low dorsal scar count and a high percentage of dorsal cortex, whereas the opposite is true for fine-grained materials. Also as expected, the more exotic materials exhibit lower percentages of dorsal cortex than do the local materials (Figure 102). Lithic materials from distant sources normally would be used as economically as possible and also would be heavily curated. In this regard, it is interesting to note that obsidian, obtained primarily from Yellowstone National Park, lacks evidence of dorsal cortex. On the other hand, Knife River flint, which has come from a considerably greater distance, retains a small percentage of dorsal cortex. Perhaps this indicates that, among the exotic lithics, obsidian was the most valued and, hence, most intensively utilized material.

As the dorsal scar and cortex attributes illustrated in Figure 102 were considered useful for pinpointing the relative reduction stages represented, we expected an inverse correlation in the plot of these values through time. For example, where dorsal scar count was highest, there should be a concomitant drop in the cortex value. Such a result was not obtained except for the silicified sediments and, to a slight degree, the silicified wood. The values obtained for porcellanite and obsidian show an obvious bias towards late stage reduction, but the remainder of the raw materials yielded unexpected results. For both the quartzite and KRF, the dorsal scar count changes little, while the cortex value varies. In the cases of the argillite, chert and particularly the SRC, an actual positive correlation exists between scars and cortex. Obviously, with these materials, other factors, particularly size, are involved.

In addition to the dorsal flake characteristics illustrated in Figure 102, a level by level comparison of the platform characteristics was also undertaken. The results of this analysis did not show significant deviations from the data on platform types already presented in Table 35; that is, the percentages of the three platform types recognized for each raw material type do not change significantly throughout the levels of the stratified area. A few, relatively minor changes were noted, however.

Flakes of KRF exhibited no cortex platforms except in levels 1 and 2. On the other hand, the highest relative frequency of multi-faceted platforms for flakes of KRF occurred in levels 4 and 5 (69.4% and 61.5%, respectively). Similarly, in levels 4 and 5, the highest values for multi-faceted platforms were obtained for SRC (44.7% and 40.0%) and chert (40.6% and 38.9%). The only porcellanite flakes with cortex platforms were recovered from level 1. Lastly, of the 11 chert and SRC flakes recovered in level 6, only one flake did not have a multi-faceted platform. The significance of the higher values for multi-faceted platforms in the deeper levels is the indication of a greater importance of late stage bifacial reduction of these materials. In later times, there appears to be a shift towards a greater representation of all reduction stages. None of these changes is radical in nature but rather represents gradual shifting, as can be seen in the dorsal flake characteristics illustrated in Figure 102.

The results obtained from the debitage analysis indicate that the greatest variation in flake morphology occurred between individual raw materials rather than within them. These differences appear to relate principally to the flaking qualities of the individual lithic types. Variation also can be attributed to a shift in reduction strategies. This is most apparent when all aspects of the assemblage are considered. A summary of the changes in debitage characteristics follows at the end of this chapter.

Ground Stone Tools

These artifacts include those that either have been modified by pecking or abrasion or have been used in an unaltered form, and all exhibit use wear. One of these, a "pestle," was recovered from the spring channel; all others were recovered from the contiguous block excavation.

Hammerstones (n=14)

These are mostly pebbles to fist-sized cobbles which have pitting on an end or projection, suggesting use as a hammer, probably for lithic reduction (e.g., Figure 99c and d). Raw materials represented include sandstone (5), non-silicified sediments (4), quartzite (4) and silicified sediment (1).

Two of the hammerstones are elongate or "sausage shaped" pebbles (Figure 99d), presumed to be flint-knapping tools with dimensions suitable for either percussion or pressure flaking. Both were found in level 3 of the block excavation. A similar specimen from level 3 also was used as an anvil (no. 74953; Figure 99c). These hammerstones were probably flint-knapping tools used during the Avonlea occupation of the site.

The four quartzite specimens and one sandstone specimen are small, rounded cobbles which have been used on several high points. Six specimens are truncated, elongate cobbles which have been used at the apex of the narrow end. One hammerstone is a wedge-shaped slab of local sandstone which appears to have been used as both a hammer and a chopper.

One hammerstone was found in level 5 of unit 50; otherwise, these were distributed in the upper three levels of the block excavation. Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX
Weight	231.8	18.5	530.0
Length	76.8	33.3	110.6
Width	54.0	23.8	83.1
Thickness	35.8	14.1	58.6

Pestles (n=7)

These are either elongate cobbles truncated to form a conchoidal or rectanguloid cross section or cobbles with a natural rectanguloid cross section (e.g., Figure 101a). The blunt flat ends of these cobbles have been used for hammering or pounding. Grinnell (1923) provides an excellent photograph illustrating "Pounding Cherries" using a conchoidal type cobble pestle identical to some of the HSI specimens. The largest of these, weighing more than 2 kg, was the only ground stone tool found in the spring channel. The other six were recovered from the top 20 cm of the block excavation. Four of the pestles are sandstone; two are made of non-silicified sediments; and one is argillite. Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX
Weight	660.1	225.1	2282.4
Length	106.8	57.9	184.0
Width	62.5	46.7	107.9
Thickness	50.1	24.7	78.1

Anvils (n=5)

These are broken cobbles of sandstone (2), siltstone (2) and quartzite (1). They have wear that can be attributed to use as anvils on either one (3) or two (2) flat surfaces. On one of the sandstone specimens, the wear is minimal; however, the utilized area was impregnated with red ochre. Apparently, this is the result of use as a platform on which the pigment was ground. The wear on the other four specimens often occurs as relatively deep pitting. Such wear is probably the result of the use of these artifacts in bipolar reduction. In most cases, the numerous pits on these anvils would have been the product of several reduction attempts. It is unlikely that the artifacts recognized as anvils represent a very large proportion of those so used. It is doubtful that many anvils would be recognized as such if they were used for a single reduction episode. Virtually any large rock could have been used as an anvil, but the vast majority of sizeable rocks, even tools and cores (e.g., Figure 101c, d and e), were salvaged for use as boiling stones and traces of other use were often obscured by such treatment. All of the anvils were recovered from levels 2 and 3 of the block excavation. Basic metric attributes of these artifacts are as follows:

	MEAN	MIN	MAX
Weight	350.8	134.2	563.4
Length	100.0	79.5	129.5
Width	60.5	49.4	84.4
Thickness	38.7	20.8	49.8

Hammerstone/Anvils (n=3)

Three artifacts exhibit wear indicative of use as both anvils and hammerstones. Hammerstone use is indicated by localized pecking on a projection; anvil use wear occurs as often very pronounced pitting on a flat surface.

The smallest of these artifacts (no. 74953; Figure 99c) is a sausage-shaped pebble of siltstone which has been used as a hammerstone at both ends and as an anvil on two opposing, flattish faces. This specimen was refit from two pieces which were recovered in near proximity from levels 2 and 3 in the stratified area of the block excavation.

The other two specimens, both recovered from level 2 near the middle of the block excavation, were used extensively as both hammers and anvils. One is a conical-shaped, truncated cobble with indications of hammering on the apex and use as an anvil on three lateral surfaces. The other is an elongate, rectanguloid sandstone cobble with a square cross section. Both ends have been utilized extensively, one as a hammer and the other probably as a chopper. All four faces have been pitted from anvil use. Basic metric attributes of these artifacts are as follows:

Artifact no.	Weight	Length	Width	Thickness
63654	566.8	144.6	59.3	42.4
66016	388.1	92.0	56.6	52.2
74953	122.3	105.9	35.2	20.4

Miscellaneous Abraders (n=5)

These are all quite different except that they were all recovered from level 2 in the stratified area of the block excavation (e.g., Figures 98h, 99g and 101b). One unusual artifact (no. 74517; Figure 99g) is the broken end of a formed, rectangular sandstone tool which had been ground flat on the end, sides and faces. Two of these have been grooved by abrasion. One abrader (no. 65068; Figure 101b) is the broken corner of a large, blocky piece of sandstone which has a single relatively broad (11 mm) and deep (3 mm) groove on one flat face which dips to the point where it is truncated by the fracture surface. Such wear is consistent with the abrasion caused by sharpening a pointed tool, such as an antler tine flaker (e.g., Flenniken and Ozbun 1988). This specimen is also very similar to one recovered during the 1984 season (Brink *et al*. 1986:152). The other grooved specimen (no. 74952; Figure 98h) is a small, tabular siltstone slab which has been etched with several long, shallow, linear grooves, apparently the result of dragging a sharp instrument over the surface. A speculative explanation for this latter type of wear may be the result of applying edge grinding to projectile points.

One artifact is a utilized, broken cobble of an unidentified, coarse, igneous rock. One perpendicularly angled edge on this specimen has been rubbed repeatedly at right angles, smoothing a large striated facet onto the edge.

The last of these artifacts is a section of the edge of a thick tabular cobble of sandstone with one face that has been smoothened from use. It looks like a fragment of an artifact similar to two specimens recovered during the 1984 season at HSI (Brink *et al.* 1986:152). Basic metric attributes of these abraders are as follows:

Artifact no.	Weight	Length	Width	Thickness
65068	281.2	78.2	71.9	47.1
65159	276.8	61.0	52.5	48.9
74517	48.4	37.4	37.4	22.2
74952	28.4	50.0	34.4	10.8
76817	99.7	49.2	37.5	26.7

Shaft Straightener (n=1)

This sandstone artifact is the rounded, broken end of a shaft straightener or smoothener (Figure 99f). One face has been ground flat and is bisected by a 2.5 mm deep and 7.0 mm wide groove. This was recovered from level 2 in the shallow deposit at the east end of the block excavation. Basic metric attributes of this artifacts are as follows:

Artifact no.	Weight	Length	Width	Thickness
68028	46.4	43.9	37.0	25.8

SUMMARY

Spring Channel Assemblage

As mentioned above, a small sample of lithic artifacts (81) was recovered from three 1 x 1 test pits in the spring channel which bisects the kill site. Our expectations of this latter aspect of the assemblage would be that it could be contrasted with the processing area material. This is partly attributable to the bias introduced by the recovery technique which favoured recovery of larger and, hence, more visible artifacts. Despite this sample bias, it did seem apparent that an overall size disparity was represented between the two areas. Both debitage and tools from the spring channel tend to be larger and exhibit little evidence of reduction other than that attributed to the maintenance of relatively large butchering tools. Localized slumping and slopewash apparently have completely mixed and juxtaposed the spring channel deposits, rendering it impossible to identify material from contemporary components, other than on a typological basis where applicable.

The most significant result of the spring channel excavations was the recovery of several projectile points of Middle Prehistoric age which included types previously thought absent from the kill site deposit. Of particular interest was the occurrence of two projectile points of the Oxbow type recovered in the spring channel excavations. These suggest that an Oxbow kill may be present at HSI. The lack of "classic" Oxbow points in the kill site assemblage recovered by Reeves led him to prefer the earlier of two dates (3130 B.C. ± 120 and 2100 B.C. ± 100) for the terminal Mummy Cave Complex use of the site (Reeves 1978:161). Given the relatively small area Reeves was able to excavate from the deposits at this depth and the relatively few points recovered from there, this result is not surprising. It should follow, therefore, that Reeves' terminal Mummy Cave be extended to the later date, assuming that Oxbow does relate to his Mummy Cave Complex. Of further interest is Vickers' observation that Oxbow communal bison kills are not known on the Alberta Plains (1986:64). If nothing else, our find at HSI illustrates that our understanding of the Middle Prehistoric Period is hindered by a generally small data base of excavated sites attributed to this time period.

Processing Area Assemblage

The following is a summary of the observed characteristics of the raw material categories defined at the beginning of this chapter. These interpretations are based on the results provided in the above artifact descriptions and on the summaries listed in Tables 36 and 37 and illustrated in Figures 103 to 105. These tables and figures provide summaries of the counts and weights of the raw material types by level in the stratified section of the block excavation. It should be noted that in Figures 103 and 104, the scale varies according to the sample size for each level and raw material.

Chert

Chert is the most prevalent raw material in terms of the actual numbers of tools, cores and debitage recovered from this assemblage. Generally, it was the dominant raw material used for the production of small, formed tools and those tools featuring a hafting modification. The versatility of this material is well expressed by its equally high representation in both bifacially and unifacially formed artifacts. Several tool categories were dominated by chert, notably projectile points (130; 41.8%), endscrapers (48; 71.6%), miscellaneous bifaces (60; 50.0%), and miscellaneous unifaces (21; 84.0%). The principle means of reduction of this material was by the bipolar technique, as indicated by 133 of the 140 cores (95%) represented of this material. Very few pieces of chert on the site are of a size which could be considered reusable since the debitage is characteristically small, resharpening or finishing flakes. Most unbroken chert tools show indications of rejuvenation to the point of exhaustion, and attempts at further reducing some of these using the bipolar technique were observed.

Chert was utilized extensively throughout the time period in which this area was in use, and an apparent trend towards more on-site production of chert tools is indicated by a progressively higher core to tool ratio from level 6 to level 1. Although the tools and debitage of chert were consistently quite small, in levels 4 and 3, which we assign principally to the Avonlea occupation, there was a shift from relatively large tools and small debitage to relatively small tools and relatively large debitage in the later period (Figure 105). This shift is coincident with a marked increase in the relative number of formed bifacial tools to MURLs from 26 to 54%. Interestingly, a similar pattern was observed of the SRC tools and debitage (Figure 105). As well, from level 4 to level 3, there is an increase in the number of bipolar cores relative to both the tools and debitage and an accordant change towards an increase in the weight of debitage relative to tools (Figures 104 and 105). These changes may be explained by a shift from transporting finished tools to the site and producing only maintenance debris in level 4, to the practice of bringing these materials to the site for reduction from pebble form in level 3. In level 4, the role of local materials is overshadowed by that of exotic and regional, but non-locally available, materials. This relationship changes by level 3, where a broader spectrum

Table 36. Summary of raw materials represented in all flaked stone tool categories by level in the stratified area, DkPj-1.

	NUMBER OF TOOLS PER LEVEL							
	1	2	3	4	5	6	7	TOTAL
CHERT	27	55	45	21	7	2		157
SRC	13	14	36	21	4	1		89
KRF	4	4		5	3	1		17
OBSIDIAN	8	4		1		1		14
PORCELLANITE	6	3						9
SIL SEDIMENT	14	30	10	7	4			65
SIL WOOD	5	23	12	3	1			44
QUARTZ			1					1
QUARTZITE	6	17	23	10	6			62
ARGILLITE	2	2	10	4				18
NON SIL SED	3	3	1					7
SANDSTONE	1		1	1				3
MISC COARSE			1					1
TOTAL	89	155	140	73	25	5	0	487

	TOTAL WEIGHT OF TOOLS PER LEVEL (g)							
	1	2	3	4	5	6	7	TOTAL
CHERT	37.3	100.5	45.7	105.6	16.9	2.5		308.5
SRC	18.4	15.1	57.5	124.8	3.1	3		221.9
KRF	3.4	2.7		2.1	3.1	0.5		11.8
OBSIDIAN	4.6	0.9		3.1		0.7		9.3
PORCELLANITE	11.1	1.4						12.5
SIL SEDIMENT	24.9	107.7	14.9	14.2	33.3			195
SIL WOOD	3.6	25.9	11.4	7.8	3.7			52.4
QUARTZ			5.1					5.1
QUARTZITE	522.6	2014.3	1080.6	346.9	766.1			4730.5
ARGILLITE	387	202.5	432.9	1101.2				2123.6
NON SIL SED	1099.4	547.7	49.6					1696.7
SANDSTONE	162.2		247.4	58				467.6
MISC COARSE			260.9					260.9
TOTAL	2274.5	3018.7	2206	1763.7	826.2	6.7	0	10095.8

	MEAN WEIGHT OF TOOLS BY LEVEL (g)						
	1	2	3	4	5	6	7
CHERT	1.38	1.83	1.02	5.03	2.41	1.25	
SRC	1.42	1.08	1.60	5.94	0.78	3.00	
KRF	0.85	0.68		0.42	1.03	0.50	
OBSIDIAN	0.58	0.23		3.10		0.70	
PORCELLANITE	1.85	0.47					
SIL SEDIMENT	1.78	3.59	1.49	2.03	8.33		
SIL WOOD	0.72	1.13	0.95	2.60	3.70		
QUARTZ			5.10				
QUARTZITE	87.10	118.49	46.98	34.69	127.68		
ARGILLITE	193.50	101.25	43.29	275.30			
NON SIL SED	366.47	182.57	49.60				
SANDSTONE	162.20		247.40	58.00			
MISC COARSE			260.90				

Table 37. Summary of raw materials represented in debitage by level in the stratified area, DkPj-1.

	NUMBER OF PIECES OF DEBITAGE PER LEVEL							
	1	2	3	4	5	6	7	TOTAL
CHERT	557	886	513	309	38	12		2315
SRC	262	271	266	175	34	11		1019
KRF	104	106	55	75	20		1	361
OBSIDIAN	150	29	8	6	1			194
PORCELLANITE	25	8		2				35
SIL SEDIMENT	170	206	92	71	19	7		565
SIL WOOD	76	164	55	9	3			307
QUARTZ	6	19	13	20	3			61
QUARTZITE	158	246	192	169	62	18		845
ARGILLITE	76	150	97	42	9	4		378
NON SIL SED	23	27	21	27	3	2	3	106
SANDSTONE	9	15	3		2	3		32
MISC COARSE	4	5	6					15
TOTAL	1620	2132	1321	905	194	57	4	6233

	TOTAL WEIGHT OF DEBITAGE PER LEVEL (g)							
	1	2	3	4	5	6	7	TOTAL
CHERT	199.4	267	532.4	140.7	22.8	5.3		1167.6
SRC	135	128.2	459.8	157.2	50.9	10.9		942
KRF	61.3	57.1	18	13.2	7		0.3	156.9
OBSIDIAN	16.3	3.4	0.8	0.6	0.1			21.2
PORCELLANITE	4.7	1.8		0.2				6.7
SIL SEDIMENT	58.7	175.1	93.7	32	17	2.1		378.6
SIL WOOD	60.6	212.7	23.8	5	5.2			307.3
QUARTZ	4.3	16.2	22.2	5.4	1.2			49.3
QUARTZITE	3339.7	2593.5	1131	875	314.2	213.9		8467.3
ARGILLITE	714.4	926.3	703.8	277.5	77.4	31.7		2731.1
NON SIL SED	144.5	220.2	555.4	950.2	1.9	41.6	48.5	1962.3
SANDSTONE	166.8	470.9	185.1		12.3	12.6		847.7
MISC COARSE	7.5	211.4	9.3					228.2
TOTAL	4913.2	5283.8	3735.3	2457	510	318.1	48.8	17266.2

	MEAN WEIGHT OF DEBITAGE BY LEVEL (g)						
	1	2	3	4	5	6	7
CHERT	0.36	0.30	1.04	0.46	0.60	0.44	
SRC	0.52	0.47	1.73	0.90	1.50	0.99	
KRF	0.59	0.54	0.33	0.18	0.35		0.30
OBSIDIAN	0.11	0.12	0.10	0.10	0.10		
PORCELLANITE	0.19	0.23		0.10			
SIL SEDIMENT	0.35	0.85	1.02	0.45	0.89	0.30	
SIL WOOD	0.80	1.30	0.43	0.56	1.73		
QUARTZ	0.72	0.85	1.71	0.27	0.40		
QUARTZITE	21.14	10.54	5.89	5.18	5.07	11.88	
ARGILLITE	9.40	6.18	7.26	6.61	8.60	7.93	
NON SIL SED	6.28	8.16	26.45	35.19	0.63	20.80	16.17
SANDSTONE	18.53	31.39	61.70		6.15	4.20	
MISC COARSE	1.88	42.28	1.55				

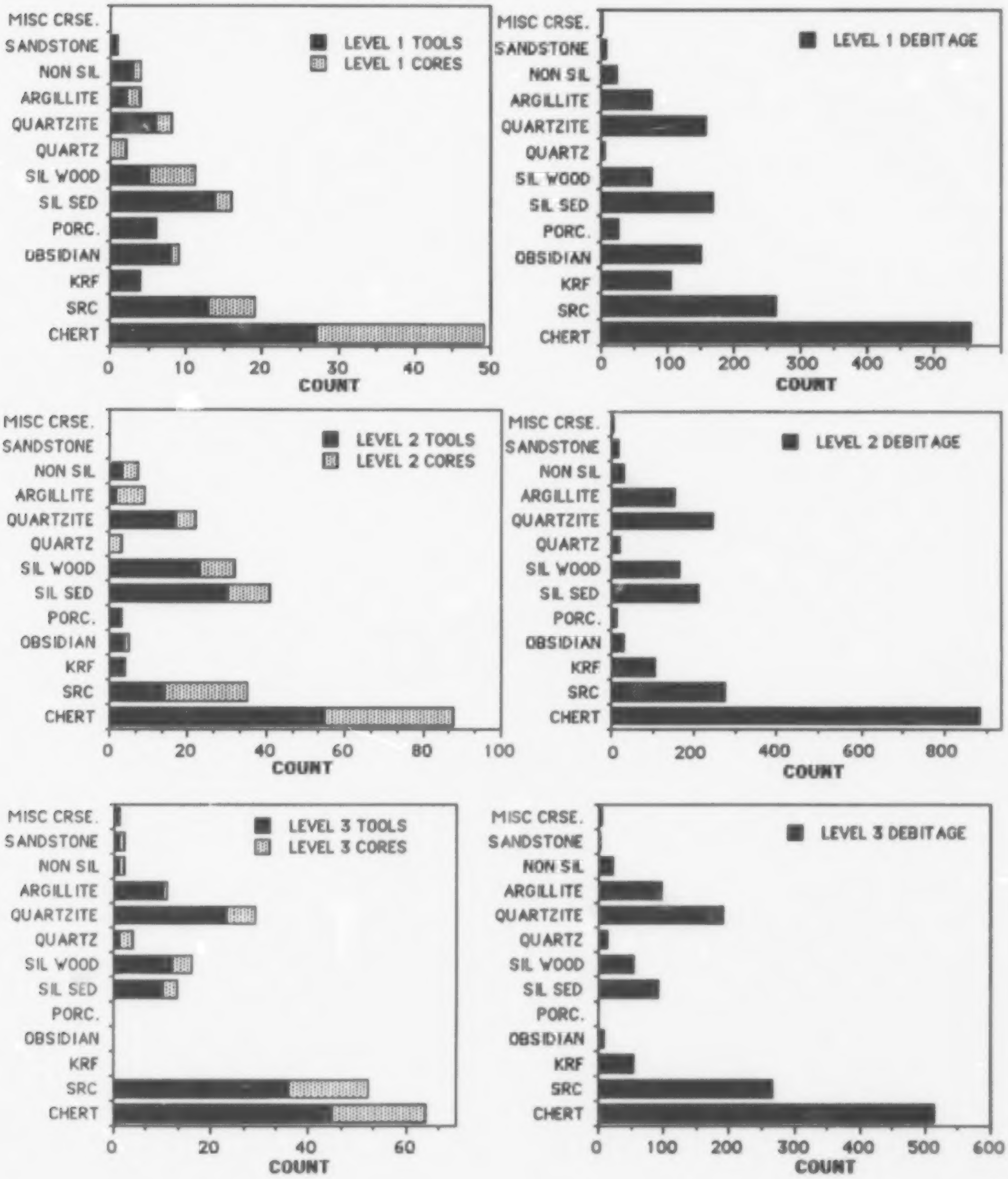


Figure 103. Summary of tool, core, and debitage counts for each raw material by level in the stratifed are in the block excavation, DkPj-1.

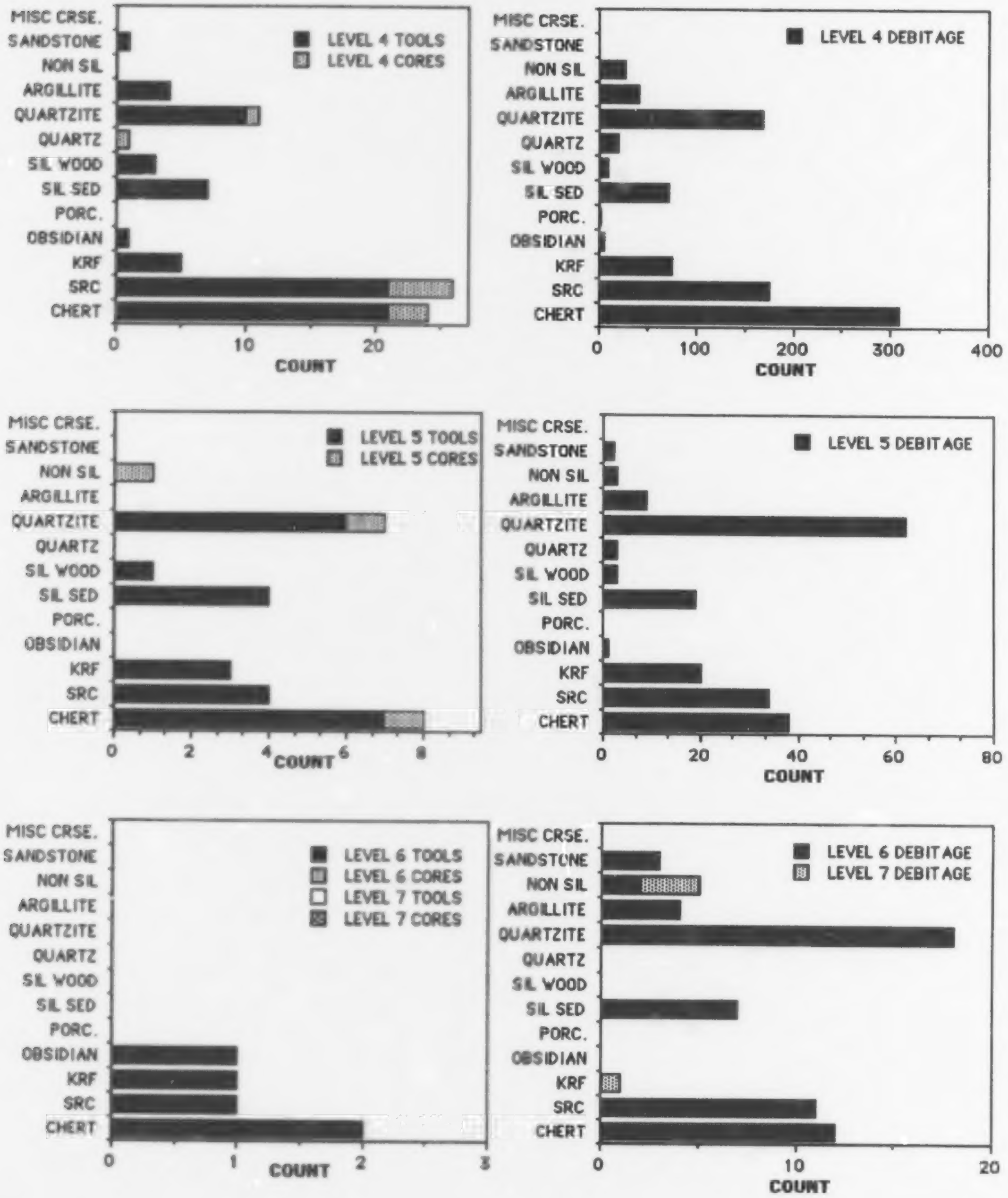


Figure 103. continued.

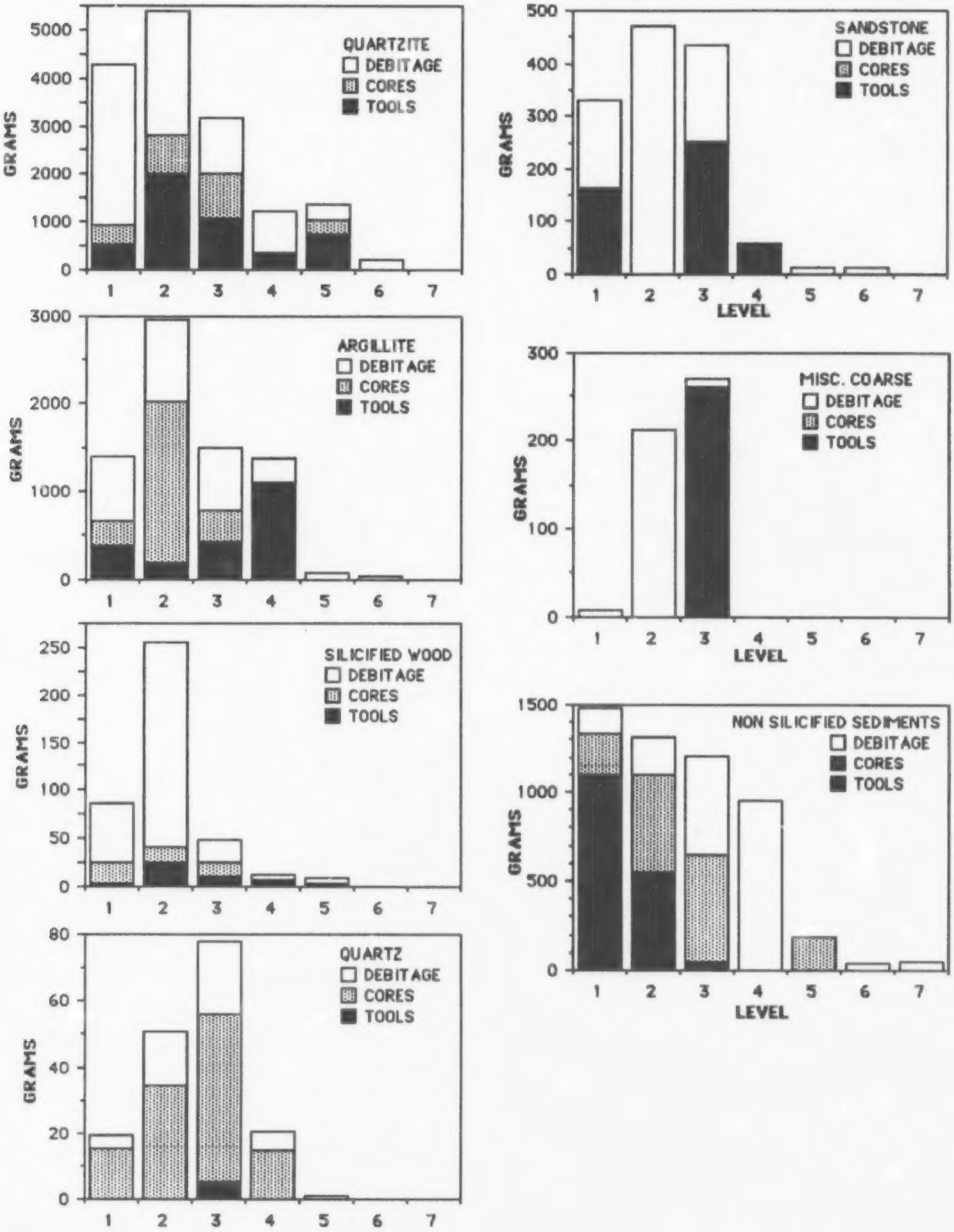


Figure 104. Summary of total tool, core, and debitage weights for each raw material by level in the stratified area in the block excavation, DkPj-1.

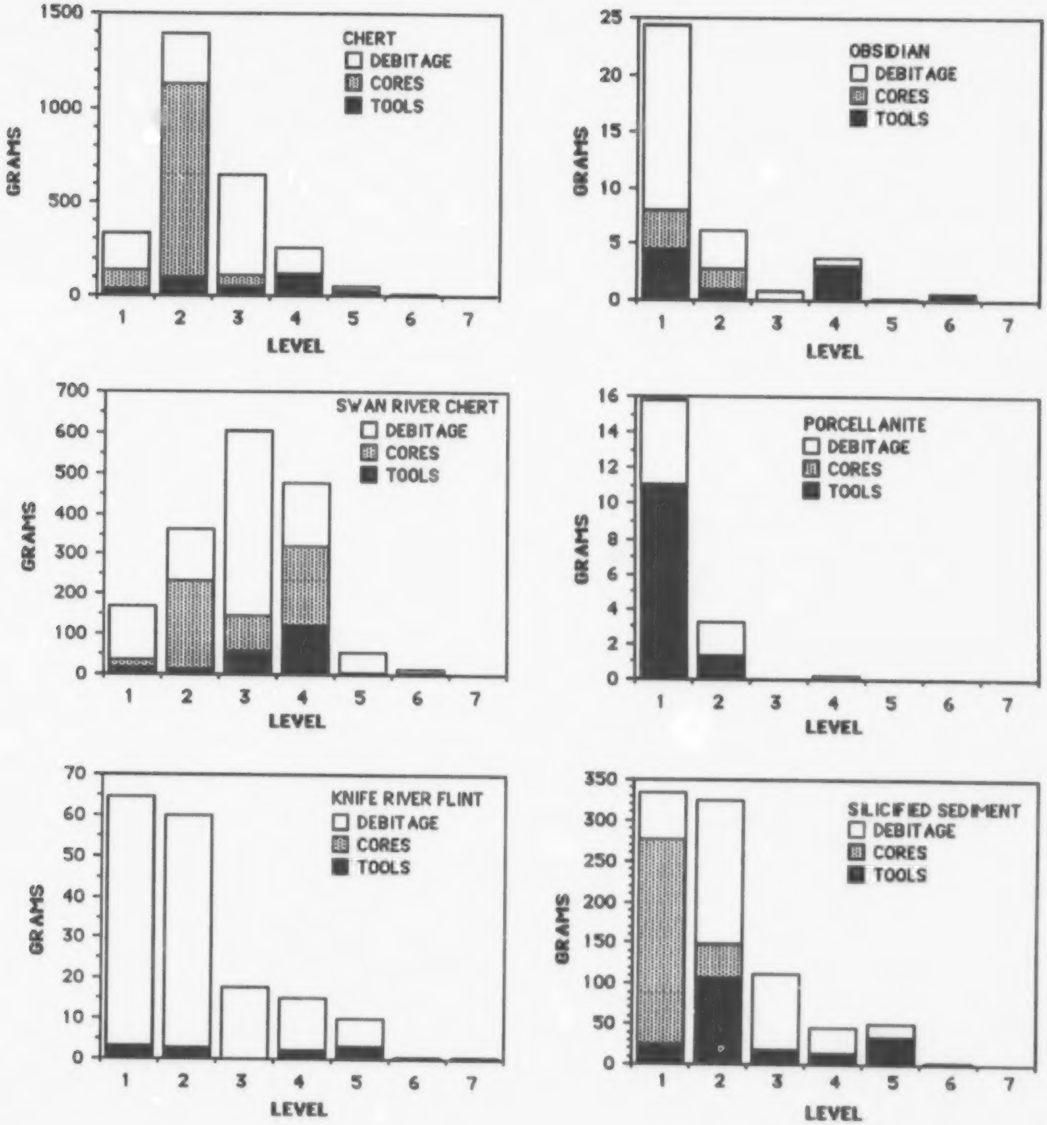


Figure 104. continued.

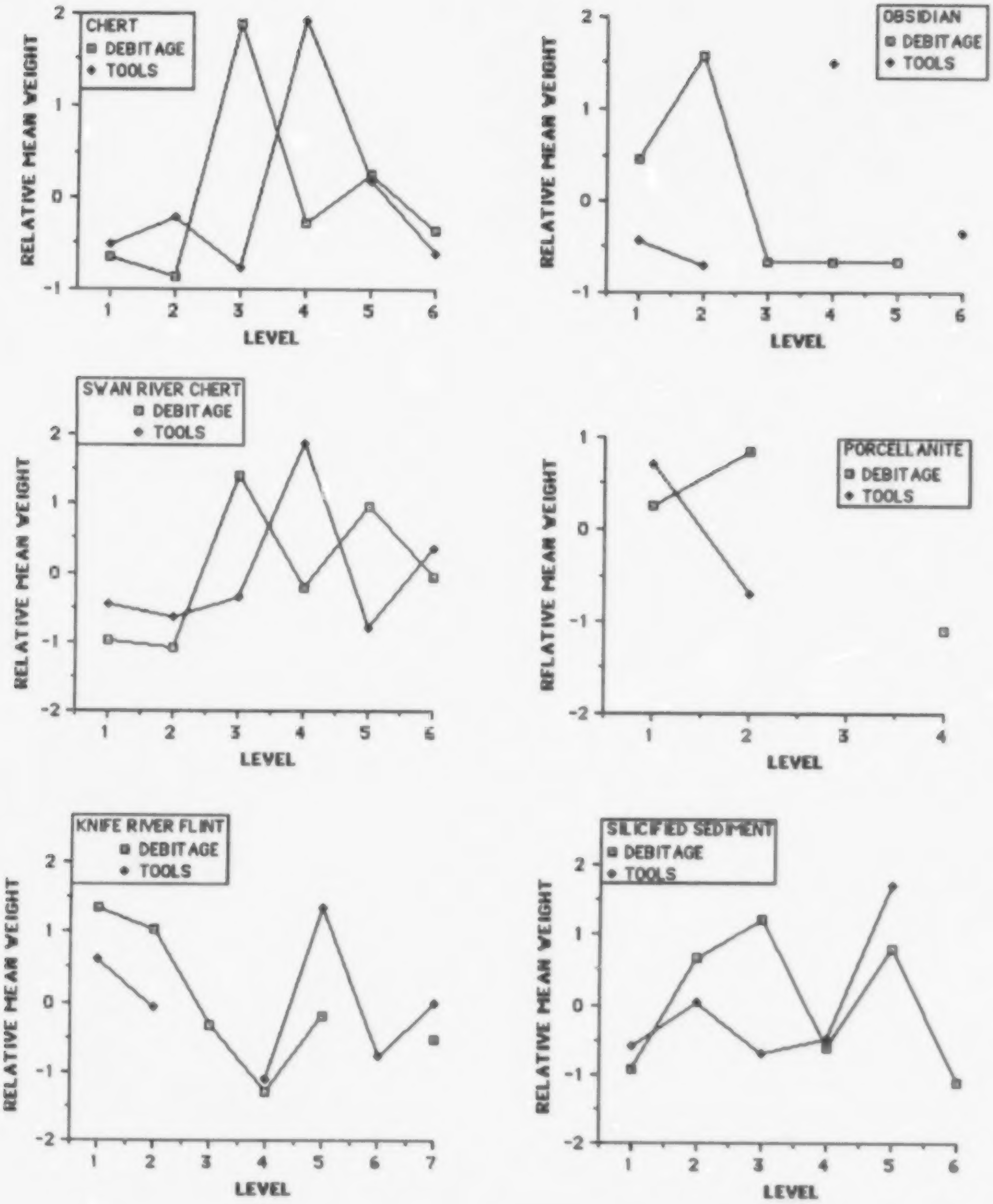


Figure 105. Standardized mean weights of debitage compared to tools of each raw material type by level in the stratified area in the block excavation, DkPj-1.

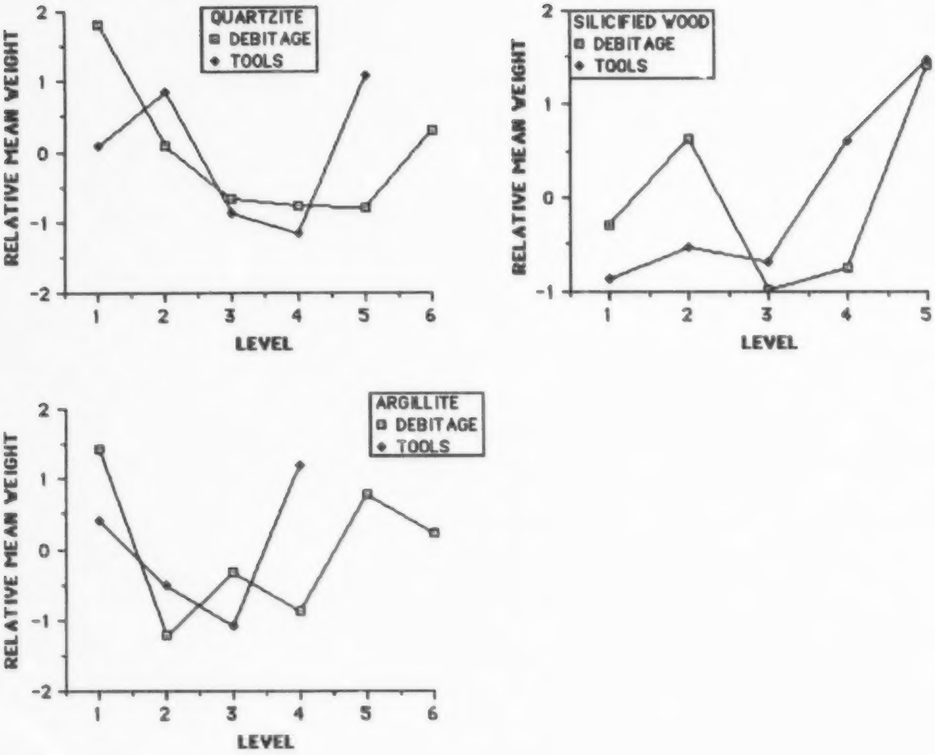


Figure 105. continued.

of local materials occurs not only in the tool categories but also in the core category.

As mentioned previously, the bulk of the cherts appear to be Madison Formation chert from Montana, and pebble cherts derived from the Laurentide till and associated river gravels. Given the extreme variability of these latter cherts, no attempt was made to separate them into source categories. Specimens that appear to be Top of the World chert include at least four projectile points, five small pieces of debitage and one bipolar core. With the exception of one projectile point recovered from level 2, all of these were recovered from the uppermost level in the processing area. Less confidence was placed on the ability to distinguish Etherington chert from the plethora of Madison and pebble chert varieties. We are reasonably certain of the identification of two bipolar cores of this material from level 1, an amorphous core from level 2 and two projectile points from levels 2 and 3.

Swan River Chert

Swan River chert is the second most prevalent raw material in terms of the numbers of tools, cores and debitage recovered from this assemblage. As the undifferentiated cherts described above are from several sources, it might be argued that Swan River chert was the single most prevalent material from any given source, however dispersed that source might be. Similar to the other cherts, Swan River chert was formed principally into projectile points (67; 21.5% of the point sample) and was particularly well represented in all bifacially formed tool categories, such as knives (10; 29.4%), hafted knives (8; 42.1%), and miscellaneous bifaces (17; 14.2%). Unlike the other cherts described above, Swan River chert was rarely used for tasks requiring a unifacial edge. For example, only two endscrapers (3%) were made from this material, and it was used for only 6 percent of all formed unifaces (as opposed to 72.7% for the other cherts). The principle means of reduction of this material was by the bipolar technique, as indicated by 90 of the total of 97 cores (92.8%) of this material. By-products of bipolar reduction of this material often were used expediently in an unaltered form, or with some marginal bifacial retouch, but rarely for scraping applications. The relatively coarse texture of this chert apparently reduced its likelihood of being reduced as effectively as some of the other more homogeneous cherts. For this reason, the SRC debitage tends to exhibit fewer dorsal flake scars than the other cherts (Table 35, Figure 102). Although SRC was found in all culture-bearing strata, it was particularly prevalent in level 4 (i.e., early Avonlea) and to a slightly lesser extent level 3 (late Avonlea).

Knife River Flint

This distinctive material has excellent flint-knapping properties and is almost exclusively represented by formed tools and tiny maintenance debris. Retouch flakes of this material were used almost invariably for expedient scraping or cutting tasks. It appears that most of the KRF that found its way to this site was probably in the form of curated tools, predominantly projectile points. Tool categories in which KRF is most prevalent include projectile points (12; 3.9%) and endscrapers (4; 6%). Only one core of this material was recovered, and it appears to have been a broken or exhausted tool from which a bipolar reduction attempt was applied. Based on the examination of the tools in the sample, bipolar reduction does not appear to be the normal means of deriving tool blanks of this material, however. The two peaks of the incidence of KRF tools occur in levels 4 and 5 and levels 1 and 2. Based on both the temporal affinity and typological grounds, we attribute the initial fluorescence of this material to a Besant component and the later one to an Old Women's component. Of interest is the apparent correlation between the relative size of tools to debitage (Figure 105), a relationship peculiar to this raw material. It seems that where big tools are available the retouch by-products tend to be bigger, and when only small tools are available, the retouch flakes are smaller. This suggests that reduction of KRF is related to that of tools rather than cores. It should be noted, however, that a few KRF flakes with cortex platforms do occur in levels 1 and 2. This may indicate some evidence of the occasional on-site reduction of this material in an early reduction stage during the Old Women's Phase.

Obsidian

This material was used almost exclusively for piercing and cutting tasks. Only one artifact of this material has been unifacially retouched. Almost half of the obsidian tools (45.2%) recovered from the processing area were projectile points (19). In addition, five biface fragments, probably parts of projectile points were recovered. As with the other fine-grained, brittle materials found on this site, very little obsidian debitage of any size was left unused. Three exhausted or worn out tool fragments of this material were reduced further by the bipolar technique. All the obsidian tools on the site were broken to some extent. Minor amounts of this material occur in all levels of the processing area, but a relatively good supply is indicated in the upper two levels, coincident with the Old Women's occupation (Figures 103 and 104). Obsidian debitage tends to be very small, except in these two upper levels where it is most prevalent (Figure 105). The one large dart point of this material in level 4 gives the false impression of a good representation of this material (Figure 104), whereas very little obsidian was actually recovered from either of the Avonlea levels. These latter observations are accordant with Reeves' (1978, 1983a) results at the kill site.

Porcellanite

More than half (52.4%) of the porcellanite in this sample was used for projectile points (11). Three bifacial knives and two triangular flake tools are the only other tool categories in which porcellanite exceeds one specimen. No porcellanite cores were recovered. The only porcellanite debitage bearing either platform or dorsal cortex occurred in level 1 (Figure 102). The debitage appears to be derived predominantly from the final stages of the reduction process, despite the occurrence of cortex on some of these specimens. Porcellanite is not well represented except for the minor quantities which appear in levels 1 and 2. Of interest is the vertical distribution in the block excavation which seems to follow closely that of obsidian (Figure 104). The correspondence between the occurrence of these two materials may relate to the near proximity of the presumed source areas for porcellanite and Yellowstone obsidian. It should be noted that two very small flakes of fused glass from level 1 were also included with the porcellanite results.

Silicified Sediments

Silicified sediments are an important source of reasonably good quality flint-knapping material, and they are available from both local and remote sources. Silicified sediments constitute the third largest group of tools (129; 12.4%) and the fourth most prevalent group of both cores (31; 7.7%) and debitage (826; 9.2 %) recovered from this assemblage. These materials were versatile and are well represented in both bifacially and unifacially formed artifact categories (Table 29). The tool categories in which silicified sediment figured most prominently include projectile points (37; 11.9%), endscrapers (11; 16.4%), miscellaneous bifaces (15; 12.5%), utilized flakes (13; 11.5%), spokeshaves (9; 34.6%), wedges (3; 60.0%), sidescrapers (8; 17.4%) and knives (6; 17.6%). It should be noted that of the silicified sediments, silicified mudstone was the variety of choice, specifically for scraping tasks, whereas the slightly more grainy silicified siltstones were relegated to cutting duties. The principle means of reduction of this material was by the bipolar technique, as indicated by 30 of the 31 cores (96.7%) represented of this material. Bipolar reduction appears to account for most of the blanks on which tools were made. Silicified sediments were used extensively throughout the time period in which this area was in use, and they appear to have provided a substitute for chert for most tasks except those requiring a delicate form with some toughness as in the use for drills and awls.

Included in the silicified sediment category were five small pieces of Kootenay argillite debitage and two projectile points. The pieces of debitage weighed less than 0.2 g each and were obtained from levels 2, 4 (2), 5 and 6. The Kootenay argillite points were found in level 2 in both the deeply stratified area and in the east, shallow, end of the excavation. Reeves (1978, 1983a) gives this distinctive material a Pelican Lake affinity in the kill site. The provenience of all but one piece of debitage of this material in a pre-c. 1,300 years B.P. context recovered in the processing area are in agreement with Reeves' results, although the evidence suggests that small amounts of this material were also used in later periods.

Silicified Wood

Although the flint-knapping characteristics of this material are constrained by the habit of fracturing along grain boundaries, this material is often very tough and durable. Its poor conchoidal fracture is exemplified by a high shatter to flake ratio of 6.8 to 1, second only to quartz. Where retouch was imparted to an edge, it tended to be a relatively straight edge paralleling the grain. Silicified wood was used almost exclusively for the production of small, expedient, marginally retouched cutting tools. Of the 86 tools of this material, unifacial retouch was only imparted to three specimens. The majority of silicified wood artifacts (61.6%) are categorized as bifacially retouched MURLs (53). This accounts for just over half of this tool category in this assemblage (51.5%). The two other tool categories in which silicified wood was most prevalent are miscellaneous bifaces (8) and projectile points (15). The major difficulty in achieving these latter forms tends to be in applying the notches which are normally oriented perpendicularly to the grain. This often resulted in the loss of an ear during the notching episode. The only evident means of reduction applied to the specimens of silicified wood in this sample was by the bipolar technique, represented by 44 cores of this material. Such a reduction technique is particularly well suited to this material since the products are usually relatively thin and tabular. Most of the debitage of this material exhibits a small, residual cortex surface. The use of silicified wood increased from level 5 to level 2, where it reached its maximum representation (Figures 103 and 104).

Quartz

This material is not an important constituent of the lithic suite used at HSI. It is very difficult to control, as indicated by the highest shatter to flake ratio (just over 10 to 1) of any raw material. Although the flake characteristics of this material indicated in Table 35, would seem to suggest that this material was represented typically by tertiary debris from finished tools, this is misleading. It was observed that the only flakes of this material which could retain their integrity upon reduction were those that were so small they lacked the numerous fractures which characterize any large piece of this material. Only three marginally retouched tools of this material were recovered (Table 29), all from level 3; however, the occurrence of cores and debitage in just about every level (Figures 103 and 104) indicates a persistent belief that it was possible to flake a tool out of this clear, glassy stone. The most frequent mode of reduction of this material was bipolar reduction (16; 94%), with one amorphous core represented.

Quartzite

Quartzite is the dominant raw material in terms of the weight of tools (10.4%), cores (7.7%) and debitage (13.4%) recovered from this assemblage. Quartzite was the material of choice for fashioning large, heavy-duty cutting and butchering tools. The toughness of this material made it particularly durable and suitable both for cutting and scraping tasks. Fine-grained quartzites occasionally were fashioned into projectile points (20; 6.4% of the point sample), but they represented a good proportion of choppers (18; 54.6%), utilized flakes (15; 13.3%), sidescrapers (10; 21.7%), unifacially retouched MURLs (10;19.2%) and knives (9; 26.5%). Five core types are represented in the quartzite category, the most variety of any lithic type. These types include bipolar cores (12), simple cobble cores (10), amorphous cores (6), bifacial cores (2) and a single spall core.

Quartzite is a particularly dominant raw material in the early levels. Quartzite is the most prevalent type of debitage in levels 5 and 6, and quartzite tools are well represented relative to their finer grained counterparts in the earliest levels. The proportion of quartzite tools and debitage relative to finer grained materials progressively declines from level 5 to level 1, although the actual numbers and weight of quartzite items increases through these levels. The characteristics of the quartzite debitage change during this time period as well. Although little change was observed in the average number of dorsal scars, averaging just under two dorsal scars for the sample obtained from each level (Figure 102), the standard deviation for these values increases from a low of 0.86 in level 5 to a high of 1.26 in level 1. Increases in dorsal cortex and mean flake size from level 5 to level 1 were observed of the quartzite debitage (Figures 102 and 105). Our interpretation of these results is that quartzite was probably brought to the site in the earlier periods in the form of finished tools, usually large or medium-sized bifaces finished with relatively large flake scars. These were presumably resharpened on site, leaving flakes which would not have much dorsal complexity nor with much cortex. A gradual shift toward on site reduction of quartzite can account for the greater mean weight, a higher incidence of cortex and greater range of dorsal scar values displayed by the end of the Old Women's occupation of the site.

Argillite

Argillite composes 3% of the tools, 6.5% of the cores and 6.6% of the debitage recovered from this assemblage. Argillite was reduced on site to produce large flakes for expedient use. Only one of the argillite tools is extensively retouched. The two tool categories in which argillite was most common were utilized flakes (15; 13.3%) and choppers (7; 21.2%). Cores of the coarser grained argillite tended to be quite large cobble cores from which a cortex platform was struck repeatedly to obtain large, thin flakes with a naturally sharp distal edge useful in the unaltered form for cutting applications. Wear frequently occurs on these specimens as linear striations oriented parallel to the edge. Such flakes usually retained a cortex surface on the dorsal face. A total of 13 simple cobble cores and six amorphous cores of argillite demonstrates this specific reduction strategy. Finer grained argillite was available in pebble form, and, although quite homogeneous, it was still soft and not very suitable for flint-knapping. These pebbles were usually reduced by the bipolar technique (n=12) to produce serviceable edges.

Argillite was employed as an expedient tool medium throughout the deposit, but it was particularly well represented in the levels attributed to the Avonlea occupation. In the stratified area, ten (55.6%) of the 18 argillite tools were recovered from level 3, and half of the remainder (4; 22.2%) were found in level 4. The frequency of argillite dropped off somewhat in the upper two levels. Of particular interest is the almost invariable occurrence of at least one localized area of pecking on flat cortex surfaces of large pieces of argillite, notably on cores (Figure 101d and e). We attribute this distinctive wear pattern to use as anvils in the bipolar reduction process. This type of wear is not as well or as frequently developed on other materials. Such a bias simply may be a result of the wear developing rapidly in this relatively soft material, whereas it would take longer to develop on harder substances, such as quartzite. An alternative hypothesis is that the softer argillite has superior qualities for this specific application. Experimentation of this reduction practice is warranted.

Non-silicified Sediments

These are principally local limestones and mudstones which do not exhibit good flaking characteristics. These materials did not form a significant part of the assemblage. All 11 tools made of this material were only marginally retouched or were utilized flakes. Five non-silicified sediment artifacts were used as choppers; otherwise, they were used expediently for cutting or scraping tasks (Table 29). As with argillite, the reduction strategy was geared towards the production of useable edges rather than tool blanks. The cores include simple cobble cores (4), bipolar cores (3) and amorphous cores (3). Non-silicified materials were utilized in all levels in the block excavation, and a general trend towards a relatively higher incidence of this material was observed in the upper levels.

Sandstone

This raw material is a very poor flint-knapping medium and composed only 0.5% of each of the tool and core classes and only 0.6% of the debitage. None of the tools was extensively modified, and no specific function of this material was preferred among the flaked stone tool categories (Table 29). The importance of this material in the assemblage was in the ground stone tool category, where 17 specimens of this material constituted 48.6% of these tools. The primary applications of this material were for abrasives, for which this material is particularly well adapted, and for pecked stone tools, such as pestles. Of the six abrading tools and seven pestles in the sample, four of each were made of sandstone.

Miscellaneous Coarse Materials

These materials are poorly represented in the assemblage and apparently were used only for flaked stone tools as a last resort. These materials played a more important role in the ground and unmodified stone tool categories. In terms of the flaked stone assemblage, miscellaneous coarse materials were never very popular. All the tools made of this material (a chopper, two edge ground flakes, one bifacially retouched flake and one utilized flake) occur in level 3. The occurrence of this material was observed to diminish from level 3 to level 1. The one core of this material is a simple cobble core which was recovered from the unstratified area of the block excavation.

Assemblage Trends

The excavations in the processing area at HSI during the 1985/86 seasons provided us with a unique stratigraphic record of lithic reduction which can be attributed to the use of this area primarily during the Late Prehistoric Period. Old Women's and Avonlea Phase artifacts are the most prevalent. Although the material from this area is clearly representative of different components and the stratigraphy is apparently undisturbed, no physical juncture was observed in the stratigraphy which would allow us to separate these two components. The one obvious disconformity was the flat, continuous, sterile lens of sand which apparently bisects the Avonlea materials into an earlier and later component. Despite the use of arbitrary excavation levels, comparisons of the projectile point typology and coincident disparities in lithic use patterns (as discussed above) reveals that, if a boundary existed between the Old Women's and Avonlea materials, it occurred at or near the 20 cm below surface level. This corresponds to the lower and upper limits of our arbitrary levels 2 and 3, respectively.

All historic or protohistoric period artifacts were recovered from level 1. Lithic materials from levels 1 and 2 are almost exclusively attributable to the Old Women's Phase occupation. Levels 3 and 4 contain predominantly Avonlea material, although some Old Women's material does occur in level 3. Earlier materials are also represented, but in minor amounts. Although Reeves (1978, 1983a) recovered significant Besant and Pelican Lake components in the kill site, only a small representation of these periods was recovered in our processing area excavations. The virtual absence of Pelican Lake material in the processing area suggests a different pattern of site utilization, one that did not emphasize the use of this area. An even earlier component, possibly related to what Reeves has described as "Mummy Cave Complex" material (1978, 1983a), is indicated by a few fragments of large side-notched or stemmed dart points and an emphasis on quartzite for butchering tools. A lack of stylistic similarity among the few projectile points attributable to this period and a paucity of cultural material in general, probably attest to infrequent visits of short duration.

Overall, several trends of lithic reduction and use are evident in the processing area at HSI. In the Late Middle Prehistoric Period, an emphasis on curated tools is indicated by a lack of cores and primary reduction debitage and a high incidence of formed tools and tertiary debitage of non-local lithic materials. The impression of the assemblage is one left by visitors who, in Reher and Frison's (1980) terminology, had "geared up" elsewhere in anticipation of a hunting event and carried their requisite tool kit to the site. Local materials were not utilized extensively by these people, possibly because they were not familiar with the area and, hence, the distribution of suitable lithic resources, or perhaps they were just not impressed with the local lithic suite. These users of the jump did not leave much behind and apparently did not use the processing area very frequently or for very long periods.

The emphasis on curated tools of exotic materials gradually diminishes to the near absence of these materials, coincident with the late Avonlea occupation, by level 3. By this time, a broader range of local materials, representing on-site reduction, were incorporated into the assemblage. Local coarse materials, often those with very poor flaking characteristics, such as those in the miscellaneous coarse and quartz lithic categories, were used expediently to augment a tool kit featuring otherwise relatively small, well-made, finished tools of materials obtained from remote areas. These non-local materials possibly were obtained during a seasonal round of activity that, in the case of the Avonlea occupation, would seem to include a swing to the east where SRC is available. The impression gleaned from this aspect of the assemblage is one of a group of visitors who had a good idea of what specific resources were available at the site, and relied on local materials to supplement a portable tool kit.

By the end of the Late Prehistoric Period, however, a greater demand on lithic material is manifest by the increased on-site reduction of all lithic materials with the marked increase in bipolar reduction from the late Avonlea occupation on. By this time, a considerable amount of lithic debris attests to a considerable amount of reduction, as well as tool maintenance, indicative of frequent and longer occupations of the site. A more efficient utilization of local and regional materials is apparent, coincident with a reduction of the use of the very coarse-grained materials for the production of flaked stone tools. A re-emergence of the importance of exotic materials in levels 1 and 2 is coincident with the Old Women's occupation. Some evidence suggests that, for the first time in this assemblage, the primary and secondary reduction of exotic materials may have occurred occasionally. The greater importance placed on obsidian, porcellanite and probably Madison Formation cherts suggests either a return to high mobility, or a resident but more cosmopolitan population which had farther reaching trade networks, particularly to the south. It might be speculated that an increased production of storable food and hide products evident in the terminal Late Prehistoric occupation may have ensured a trade medium for other goods, such as lithic material.

Discussion

The continued excavations in the processing area have furthered our knowledge of the kind of lithic assemblage which might be expected from a bison butchering site. The results of the 1985 and 1986 field seasons have added a temporal perspective to the record of the use of lithic material in the processing area at HSI, particularly as it pertains to the use of the site during the Late Prehistoric Period. Some general observations can be made about the lithic assemblage from the processing area which are true of the samples from both the stratified and non stratified materials recovered not only in the 1985 and 1986 seasons, but also in 1983 and 1984 (Brink *et al.* 1985, 1986).

There is an abundance of lithic material at HSI, representing a broad spectrum of lithologies from a wide variety of sources. The ample evidence of lithic reduction in the processing area indicates that disparate reduction strategies were employed to optimize the application of this very heterogeneous lithic suite (Dawe 1987a). At HSI, there is virtually no stone available on site which is useful for flint-knapping. The sandstone that outcrops here is relatively soft and coarse-textured; however, these attributes do make this stone useful for ground stone tools, particularly abrasives. The nearby local glacial tills and river gravels provide an abundant supply of medium- to coarse-grained rocks, such as quartzite and argillite, more suitable for flint-knapping and small amounts of finer grained materials which tend to exhibit relatively poor conchoidal fracture. These include pebble cherts and particularly silicified wood. These local materials were an important aspect of the assemblage, since they provided a source of material to be reduced expediently on site to augment an otherwise largely curated and portable tool kit. Local materials provided the bulk of the heavy duty butchering tools found on site, as well as the majority of small, expedient, marginally retouched or utilized flake tools, are represented by all stages of the reduction process.

In contrast to the portion of the tool assemblage made of local materials, a curated aspect of this assemblage accounts for the majority of the formed tools found on the site. Such curated tools were brought to the site in finished or nearly finished form and typically were made of fine-grained materials. These were obtained either directly from remote locations, probably during an annual subsistence round, such as from the Rocky Mountains, or by trade from distant locations, as in the case of Knife River Flint from North Dakota. This curated aspect of the assemblage is manifest at HSI by a large number of worn out or broken, small, formed tools which often show a high degree of maintenance and rejuvenation. The remote and exotic materials are represented primarily by the final stages of the reduction process, as indicated by the vast numbers of minute retouch flakes of these materials, which weigh less than a tenth of a gram, and by the general absence of primary or secondary reduction flakes or flakes bearing cortex.

Generally, the users of HSI were very frugal with fine grained materials. The intense recycling of lithic material at this site resulted in the reduction of virtually every sizeable piece of fine-grained isotropic material, often by the bipolar reduction method. Bipolar reduction is relatively inefficient compared to direct percussion or pressure in that it is less predictable and produces a higher amount of useless shatter; however, it is the most effective means of retrieving useful edges from pieces too small to be reduced by other means. The artifacts produced by the bipolar method are often expedient tools used for the wide variety of maintenance tasks expected in a camp site situation. Such small, expedient, marginally retouched or simply utilized tools dominate the tool assemblage, a characteristic of the processing area not duplicated in the kill site assemblage.

The results of our test excavations in the spring channel during the 1985 and 1986 seasons and the results of Reeves' kill site excavations (Reeves 1978, 1983a) indicate that the lithic remains from the kill site assemblage present a record that is at contrast with the assemblage recovered from the processing area. The kill site assemblage is dominated heavily by a narrow range of artifact types, suggestive of a few utilitarian activities relating to the killing and butchering of animals. Actual reduction of lithic material in the kill is relatively poorly represented and is narrow in focus - the rejuvenation of large butchering tools seems to be the primary reduction activity represented. The processing area, on the other hand, features a broad range of artifact types reflecting the numerous extractive and maintenance activities that could be expected in a camp site situation. Less utilitarian artifacts, indicative of domestic activity, also appear in this area. For instance, the occurrence of lithic toys and bone ornaments in the processing area suggests band participation rather than specialized task groups, at least in the Late Prehistoric Period.

Projectile points are the most common formed tools in both the processing and kill site assemblages; however, the proportion of projectile points to other tools, indeed to all the other artifacts found in the kill site, is much higher. For example, more than 50% of the entire lithic assemblage recovered by Reeves from the Old Women's and Avonlea components in the kill site were projectile points (Reeves 1983a). These results are corroborated by our small spring channel tests which yielded 29 (36%)

projectile points from a multi-component, flaked stone assemblage. This is in marked contrast to the processing area where projectile points constitute less than 2% of the entire flaked stone assemblage. Still, of all formed tools, points are the most numerous at the HSI processing site.

Of further interest is the observation that Reeves recovered a considerable amount of cultural material attributable to the Middle Prehistoric Period in the kill site deposits. This representation was not duplicated in the processing area below the jump. Despite our widespread testing of the camp site and processing area in four years of excavations, very little cultural material of any kind could be attributed to a Middle Prehistoric use of this area. Moreover, Reeves observed of the Middle Prehistoric Period assemblage in the kill site a much higher proportion of debitage and butchering tools relative to projectile points than was recovered from the Late Prehistoric components (Reeves 1978,1983a). Reeves has suggested that the relatively poor representation of Middle Prehistoric dart points at the HSI kill relates to technology. In other words, retrieval of dart shafts was more likely than the retrieval of arrow shafts; hence, the dart points were removed with the shafts (Reeves 1978:166).

It makes sense that, given the lack of fine-grained material in the HSI area, broken dart points would be retrieved for rejuvenation or perhaps reworking into other tool forms. Hence, these would be removed from the archaeological record. Unlike Reeves (1978:166), who argues that dart shafts were more likely to be curated than were arrows, we would argue that retrieval of both arrow and dart shafts would always be a concern. The amount of human labour involved in the production of both dart and arrow shafts is considerable, much greater than the work required to tip these weapons, and would result in the retrieval of all wooden shafts. Thus, the relative frequencies of dart and arrow points at the site cannot be attributed simply to the selective curation of one particular weapon system.

It can also be suggested, however, that the observed variation in artifact frequencies is as much a reflection of the conduct of other kinds of activities at the kill site as it is a selective removal of projectile points; that is, the data from the Middle Prehistoric use of the kill show a high incidence of occurrence of other kinds of lithic artifacts, specifically coarse quartzite flakes, presumably used as or were removed from butchering tools. The frequency of these tools diminishes dramatically in the Late

Prehistoric Period, while the later types of points (Avonlea and Old Women's) show a marked increase (Reeves 1983:135). Thus, it can be suggested that changing activities through time have created the differential artifact frequencies at the kill site and not just the selective removal of certain points, as suggested by Reeves.

Data from our own excavations tend to reinforce the interpretation that the observed variation in artifact frequencies in the kill site relates to a dramatic shift in the use of the jump between the Late and Middle Prehistoric periods. Specifically, the paucity of all Middle Prehistoric cultural materials on the prairie level suggests that killing and primary butchering were conducted beneath the cliff and were followed by abandonment of the site. The intensive post-kill use of the prairie level, so evident in Late Prehistoric times, is not indicated for the Middle Prehistoric Period. Frison (1982) and Kelly and Todd (1988) have documented this pattern of expedient use of bison with minimal processing at Palaeo-Indian kills in the northern Plains. It may be that this pattern continued, at least in some areas, well into the the Middle Prehistoric Period. We would argue, therefore, that it is plausible that the differential use of the kill and processing areas through time may account for the skewed relative frequencies of lithic artifacts during the early use of the HSI kill site. Undoubtedly, healthy debate of these and numerous other aspects of the lithic assemblage at HSI, and at other Plains bison kill/butchery sites, will continue for some time to come.

CHAPTER 8

CERAMIC, HISTORICAL AND BONE ARTIFACTS

CERAMIC ARTIFACTS

A total of 279 pieces of pottery was recovered in the 1985 and 1986 field seasons. The provenience of these artifacts is summarized in Table 38. The pottery recovered from units 4 and 48 consists of four very small sherds or, perhaps more appropriately, crumbs, which have broken along laminations and, hence, are each missing one face. Since these remnants have no apparent decoration or orientation, no further attention was considered warranted other than the mention of their occurrence.

With the exception of ten rim sherds, three neck sherds and two shoulder fragments, the bulk of the pottery is represented by small body sherds in very crumbly condition. The largest sherd, an undecorated body sherd recovered in unit 43, is 5 cm long and 1.5 cm thick and weighs 31.5 g. Most sherds are much smaller, however; the average weight is only 1.3 g (SD. = 0.65 g). The decoration on the body sherds, where present, is limited to a fabric impression which appears to be smoothened, cord-wrapped stick impressions. For the most part, these fragments are unanalyseable, other than to provide paste and temper characteristics. These latter attributes are similar to those recovered in previous excavations at HSI (Brink *et al.* 1985, 1986), and have been described in some detail by Hanna (1986).

Table 38. Distribution of pottery by level and unit at DkPj-1.

	BLOCK EXCAVATION UNIT							TEST UNIT		
LEVEL	41	44	45	46	47	49	50	43	4	48
1	35	71	11	18	8	53	19	4*		1
2	6	6	6	3	3	10	5		3	
3		1	1	1	1	3	5			
4		1				1	3			
TOTAL	41	79	18	22	12	67	32	4	3	1

*level 1 in unit 43 is 0-30 cm below surface

Four sherds, including a possible neck sherd, two undecorated body sherds and one decorated shoulder sherd, were recovered from the top 30 cm level of test unit 43. The neck sherd has a smooth exterior which has been decorated by means of at least five straight, 0.8 mm. wide, parallel incisions spaced 3.5 to 4 mm apart (Figure 108f). This design was incised into the sherd in its plastic state and was not subsequently smoothened. The shoulder sherd (Figure 107a) represents an angular, excurvate ridge formed at the shoulder. The surface finish on this sherd appears to be a truncated, cord-wrapped stick impression, and the angular shoulder edge has been incised with parallel, nearly vertical incisions. These incisions are 14 mm long and 3 mm deep and are spaced 5 to 6 mm apart. They were formed by scraping with an instrument which left one inside face of the incision smooth and the other longitudinally striated.

A total of 271 pieces of pottery was recovered in the contiguous block excavation. The distribution of this pottery (Figures 106 and 107) indicates a relatively dense concentration in the southwest end of the block, and a somewhat less dense concentration 1 m to the west (Figures 106 and 107). It is quite likely that many of the specimens were derived from a few common pots; however, the fragmentary condition of these prohibits reconstruction. The total weight of all the sherds could be accounted for by a single pot; although, the occurrence of at least six different rim styles here would argue against that interpretation. Given the small sample size, and the impossibility of vessel reconstruction, it is hard to evaluate if the concentrations of ceramics are the result of cultural activity or post-depositional processes. What seems most likely is that, upon being discarded or abandoned the pots broke into a few large portions which may have been laterally displaced about the area and then further reduced more or less in situ into the clusters of small fragments with the distribution indicated in Figure 106.

Ten rim sherds were excavated from the block excavation, including eight from level 1 and one each from levels 2 and 4. Of these rim sherds, two pairs share identical decoration and were found close together in level 1, indicating that they were derived from common pots. The attributes of these sherds are described below.

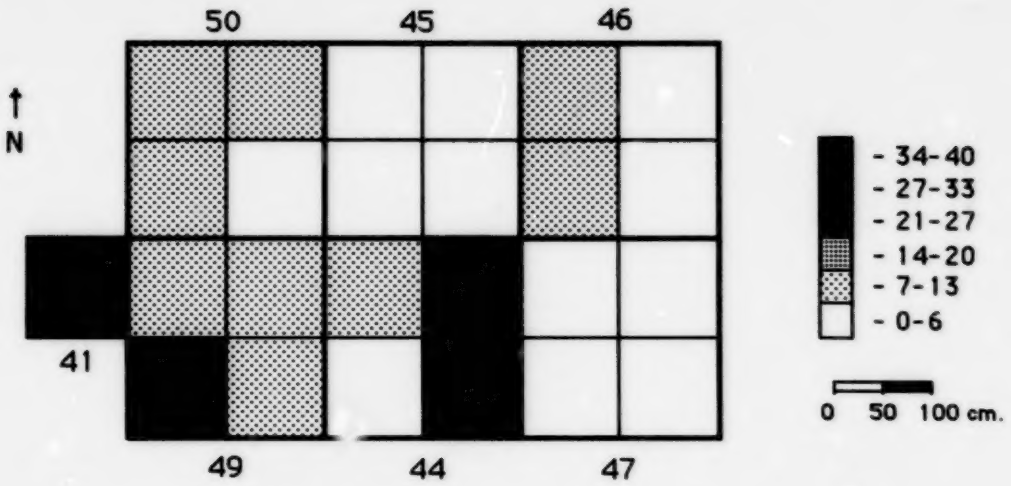


Figure 106. Pottery distribution by number, all levels.

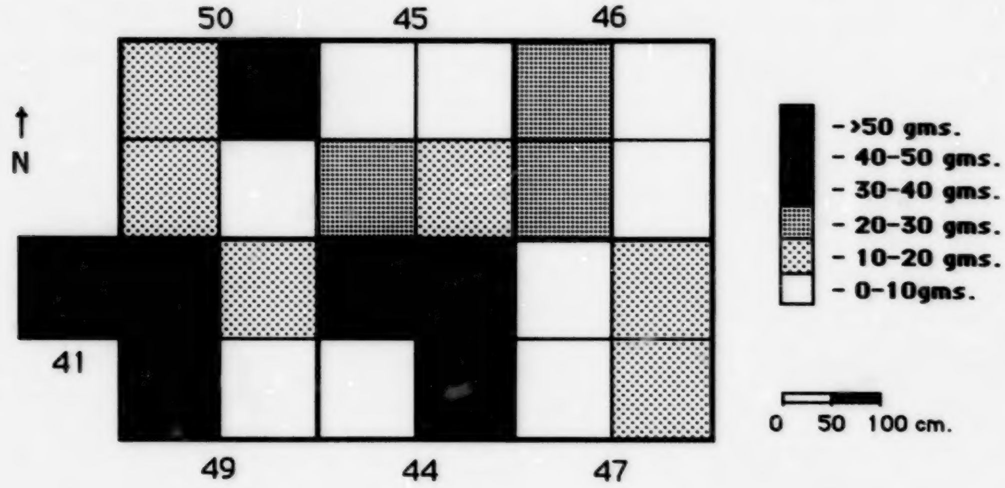


Figure 107. Pottery distribution by weight, all levels.

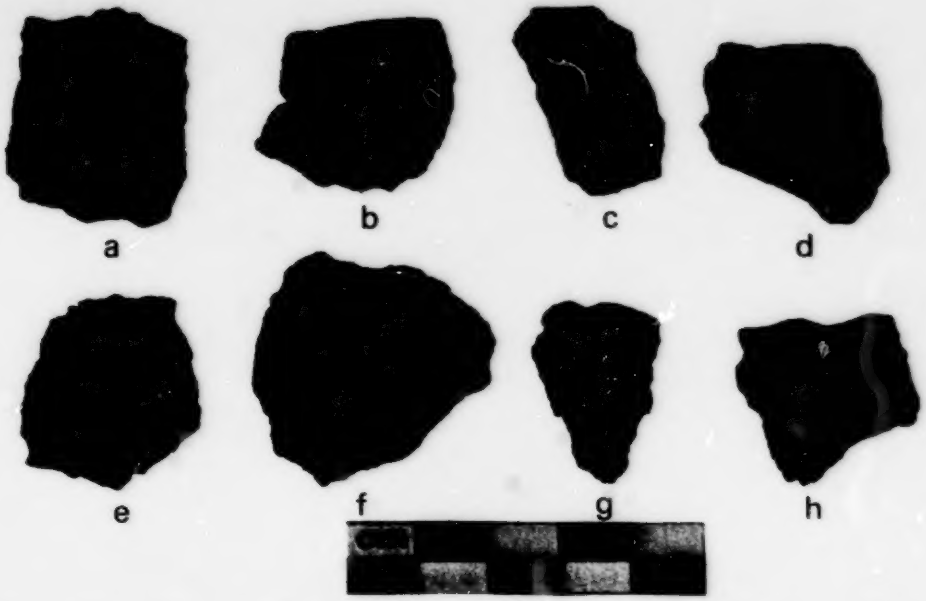


Figure 108. Pottery - incised shoulder sherd: a; fabric/cord-wrapped stick-impressed rim sherds with etched lips: b-d; knotted cord-impressed shoulder sherd: e; parallel incised neck sherd: f; horizontally fluted rim sherd with diagonal, cord-impressed lip: g; alternate pinched lip impressed rim sherd: h.

73279

This artifact is a small fragment of a rim, expanding to a 17 mm wide, flat, plain lip.

73282

This sherd has a single, oblique, 1 mm wide incision on the lip. The exterior face is missing. The rim has an infolded profile.

73332 and 73333

Decoration on these sherds consists of transverse fingernail impressions, spaced 3 to 6 mm apart, with an outfolded rim profile and a rough fabric- or cord-impressed exterior (Figure 108b and c).

73391 and 73392

Decoration consists of shallow 0.5 mm wide transverse incisions, 6 to 8 mm apart, etched with a fingernail or a sharp instrument (Figure 108g and h). The exterior has a smoothened, vertically trending, cord-marked surface finish. The rim is parallel in profile and outsloping.

79016

This sherd has an infolded lip on a parallel rim profile, with a single, 1.5 mm wide oblique tool impression and a smoothened, vertically trending, cord-marked exterior (Figure 108d).

79030

This is a plain, undecorated rim sherd with a parallel rim profile, a flat lip and a slightly burnished exterior lip edge.

In addition to the rim sherds described above, one shoulder sherd and two undecorated neck sherds were recovered in level 1. The shoulder sherd is quite small but has a smoothened, possibly knotted, cord-impressed surface finish (Figure 108e). The pottery from level 1 contains elements that appear to be most consistent with attributes characteristic of period 2 and 3 Saskatchewan Basin pottery as described by Byrne (1973).

The one rim sherd found in level 2 (no. 73328; Figure 108g) has a deep, 2 mm wide, obliquely angled, cord-wrapped stick impression on the lip and a deeply, horizontally fluted exterior; the lip is thickened and rounded in profile. Based on the co-occurrence of horizontal fluting and lip thickening, this rim stylistically would be most consistent with period 2 of the Saskatchewan Basin Complex, after Byrne (1973), which he dates from 1,150-1,700 A.D.

The association of Old Woman's Phase projectile points and a date of 800 ± 90 years B.P. on bone collagen from level 2 suggests that the pottery from the uppermost two levels in the block excavation is in agreement with the middle and late variants of Saskatchewan Basin pottery as described by Byrne (1973). Although Cluny Complex or One Gun Phase materials have been reported previously from HSI (Byrne 1973:651), none was observed in this sample.

The piece of pottery recovered from level 4 in the block excavation is a rim fragment (no. 78944) which has been decorated with an alternate pinched lip impression (Figure 108h). This lip treatment is a characteristic attribute of pottery associated with the Avonlea Phase in southern Alberta (W. Byrne, personal communication 1987) and can be assigned to period 1 of the Saskatchewan Basin Complex (Byrne 1973). This rim sherd was recovered from level 4 (30-40 cm below surface), below the largely sterile lens of sand discussed in Chapter 3 . A radiocarbon determination on bone collagen of 1360 ± -140 years B.P. (AECV 375C), as well as the recovery of Avonlea style projectile points from this same depositional context, support the identification of this rim sherd as belonging to the Avonlea Phase component.

HISTORICAL ARTIFACTS

A total of 28 historical artifacts was recovered during the 1985/86 excavations at HSI, including 18 scraps of various metals, a brass knife blade, an iron buckle, a strap of cut leather, two pieces of bottle glass, two bottle caps and one glass bead. All of this material was recovered from excavated contexts and will be discussed below according to its provenience.

Spring Channel Test Units

A machine cut, leather strap and a small iron buckle were recovered from unit 39; a piece of amber (beer bottle?) glass, a 2 1/2 inch common nail and a "Hires" root beer bottle cap were found in unit 40; and a unidentifiable, rusted, cork-lined bottle cap was excavated from unit 42. This historical material is essentially modern and would be of little interest except for the context of its discovery. All of these artifacts were found at a depth equal to or, in some cases, much deeper than projectile points which are considerably older, notably several Middle Prehistoric dart points. The co-occurrence of materials of such disparate ages clearly reflects the degree of disturbance in the active depositional environment of the spring channel.

Of further interest was the recovery of a piece of leather strapping. Although of no considerable antiquity, this artifact was supple and in an excellent state of preservation, lending support to our hope of recovering prehistoric artifacts of soft, organic tissues in these water saturated deposits.

Block Excavation

A total of 17 scraps of metal, a bead and a knife blade were recovered from the block excavation. These items were excavated from below the surface, but all were in the upper 10 cm level. The distribution of these artifacts is described below and is illustrated in Figure 109.

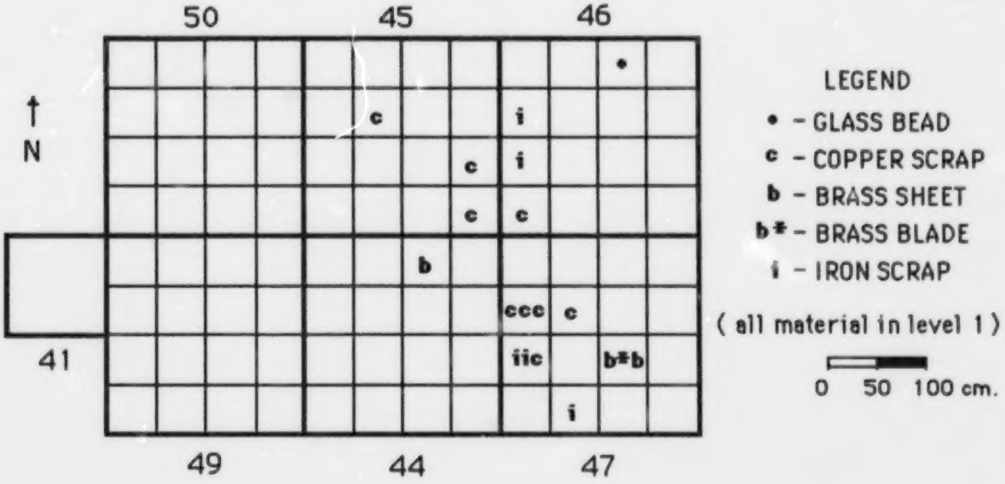


Figure 109. Distribution of historical artifacts recovered in the block excavation at DkPj-1.

Brass Knife (n=1)

A single, roughly rectangular piece of brass, measuring 33.3 x 10.9 x 0.7 mm, with a straight, double-bevelled cutting edge was recovered (Figure 110t). This artifact is similar to two specimens recovered by Forbis (1977) at the Cluny site (EePf-1), which he describes as blades designed for insertion into rib bone handles. The description provided by Forbis can aptly describe this artifact as well:

> . . . [this specimen] is coated with a green patina. The cutting edge, though dull, is sharper than the other edges, which were sheared irregularly. The cutting edge is rounded at one or both ends [one]. Surfaces are smooth, although they appear to have been hammered, and thickness is relatively uniform (less than 1 mm) (Forbis 1977:67).

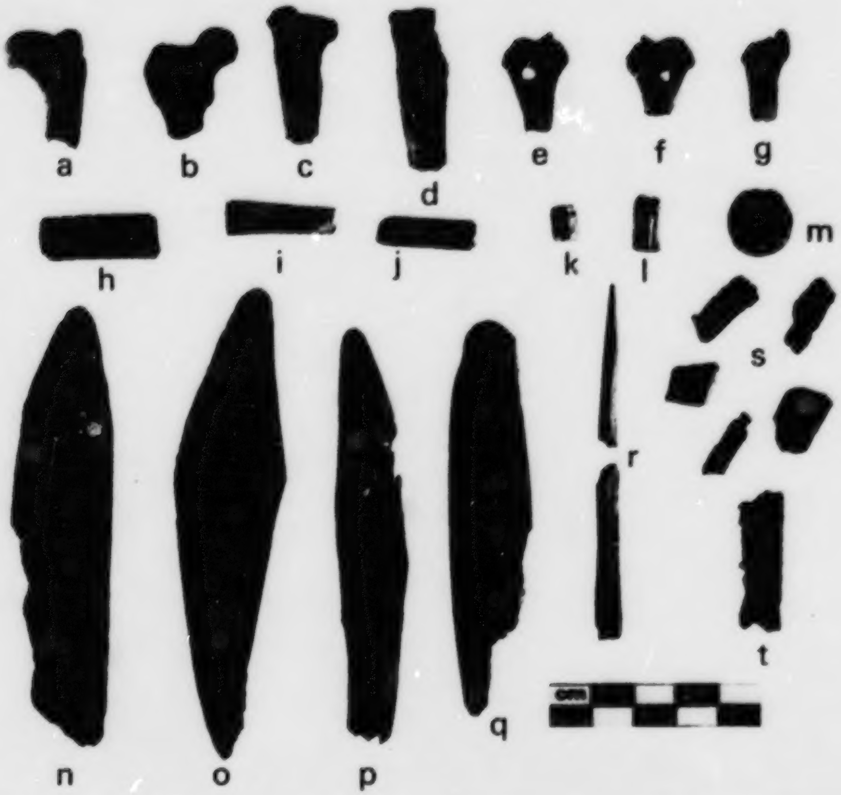


Figure 110. Bone and Historical Artifacts - bone bead production waste: a-g; bone bead with decorative incisions: h; bone bead blanks: i, j; polished bone beads: k, l; button blank: m; pointed bone fragments: n-p; gaming piece: q; broken bone awl: r; copper scraps: s; brass knife blade: t.

The blades recovered by Forbis measured 53 x 15 mm and 40 x 9 mm, respectively; both were somewhat longer than the specimen we recovered.

Brass Sheet (n=2)

Both pieces of brass sheet are 0.3 mm thick. One is a jagged scrap, less than 10 mm long, and the other an approximately rectangular strip measuring 33 x 24 mm, apparently broken from a longer strip having two smoothened opposing edges.

Copper scrap (n=8)

These are scraps of 1.2 mm thick copper sheet which appear to be the by-product of a single, tool-making event (Figure 110s). Each has a roughly triangular to quadrilateral outline; all the margins have been cut from one face, leaving broad, single-bevelled, scalloped edges. The means by which this metal was cut appears to have been by hammering with a chisel-like action but with a relatively blunt edge, such as would be found on an axe. We can only speculate what was being made, but metal arrowheads are a likely candidate. Such a practice is recorded in the early Historical period when the chiselling of any such metal into arrowheads was a common practice of the natives of the plains (Wissler 1910:122).

Iron Scrap (n=5)

These are small (less than 1 g), thin pieces of badly rusted iron of unidentifiable origin. They may be relatively modern.

Glass bead (n=1)

A single, blue, glass seed bead was recovered (and promptly lost) during the 1985 field season.

Prairie Level Test Pits

Unit 43

A single piece of clear bottle glass of presumably modern origin was found during the excavation of the uppermost 30 cm level of this unit. As this feature had been exposed by the excavation of the adjacent well-head by heavy equipment, it is possible that this piece of glass was accidently intruded into the deposit during this excavation.

Unit 48

A single scrap of cut, 0.7 mm thick copper sheet was recovered from this test excavation. Other than the difference in thickness, this artifact is similar in all respects to those pieces recovered from the block excavation, including evidence of having been cut by a chiselling action.

BONE TOOLS

A total of 23 bone specimens was identified as either worked bone or utilized bone tools. Worked bone specimens relate primarily to bone bead production. Typically, we recovered the discarded articular ends of small long bones used to produce beads (n=7) or the actual beads themselves (n=5). Other worked bone includes two fragments of a bone awl, a probable bone button blank and a cut bone which may have been used as a gaming piece. Utilized bone tools consist of either long bone (5) or rib fragments (3) that have one pointed end which has been clearly rounded or polished as a result of use. In addition to these clearly utilized specimens, there were numerous long bone and rib fragments which exhibited a lesser degree of rounding or polish on one end, some of which may be attributable to tool use. However, as other post-depositional factors may have been responsible for this attrition, no further discussion of these was deemed warranted.

Bone Beads and Bead Waste

These are portions of small mammal limb bones which represent all stages of the bone bead manufacturing process (Figure 110a-l). The bone elements used have been selected apparently because they had the common features of a hollow cylindrical shaft with a relatively narrow diameter. Manufacture of beads was accomplished by incising two narrow grooves completely around the shaft and snapping the bone at these points. Thus, several cylindrical beads can be made readily from one small limb bone with the marrow cavity facilitating the thong or string. Both the articular ends and bead blanks have remnants of the encircling grooves used to snap these bones; however, polishing of two finished beads has removed most evidence of the grooves. All of these specimens were recovered from the large block excavation in the processing area. A total of seven artifacts relating to bead production was recovered from the stratified part of this area, all from the upper three levels in contexts associated with both Old Women's and late Avonlea material .

Seven of the artifacts are articular ends which were discarded after the desired shaft sections were obtained (Figure 110a-g). Faunal elements represented include the left and right proximal metatarsals of a large dog or wolf, the right and left distal humeri of a fox, the left distal tibia of a fox, the right proximal humerus of a fox, and the right proximal femur, possibly of a small dog. The maximum and minimum diameters of beads that could have been derived from these would be 11 mm and 6 mm respectively.

Two shaft segments did not break evenly on one end and appear to have been discarded (Figure 110i and j). These bead blanks measure 23 and 26 mm in length, with a diameter of 7.5 and 8.3 mm, respectively. Two other shaft segments have a smoothened polished exterior and appear to represent the finished product (Figure 110k and l). These measure 13 and 8.4 mm in length and 7 and 7.3 mm in diameter, respectively, and both have an inside diameter of about 3 mm. On these latter specimens, polishing has completely obscured the evidence of the original grooves used to snap these beads.

One additional specimen is the largest shaft segment, measuring 23 mm in length and 10 mm in diameter, with an oval cross section. This artifact appears to be unfinished, in that it has not been polished, and the remnant of a groove is clearly visible on either end. On the lateral margins, five opposing pairs of small, short, parallel grooves about 4 mm long and oriented perpendicular to the long axis of the bead occur (Figure 110h). This placement of these grooves may have served as marks for future grooving for the further division of this specimen into several smaller beads; however, because these are spaced so closely together, it seems more likely that they may be decorative. This artifact was recovered from level 3 in Unit 41 in the stratified west end of the block excavation.

Awl

The non-adjoining distal and proximal ends of a narrow and quite sharp awl were recovered in level 2, unit 49 (Figure 110r). Both pieces were approximately 2 cm long, and, when complete, the awl probably measured about 10 cm in length. The maximum width of 6.5 mm occurs at one end, from which the specimen tapers evenly to a sharp tip. The bone used to make this has a solid, triangular cross section and looks very much like a section of the fibula of a large dog; however, the grinding of much of the surface of this artifact prohibits a positive identification.

Bone Button Blank

This is a ground flat, circular disk of bone measuring 16 mm in diameter and 2.5 mm in thickness (Figure 110m). It was recovered from level 2, unit 45. This artifact appears similar in both size and shape to a button except that it lacks holes.

Gaming Piece

This artifact is a flat, sagital section of a thoracic vertebrae spine which measures 92 mm long, 19.5 mm wide, and 5.5 mm thick (Figure 110q). It was recovered in level 2, unit 50. The outline shape appears to have been cut originally and smoothened to a symmetrical, elliptical form; however, one end is broken. The intact end is rounded, and the cancellous bone that forms one face has been scraped or ground flat, lending an even uniform thickness to this artifact. Although undecorated, the form of this artifact is suggestive of a gaming piece. Ewers (1985:154), for example, describes a game enjoyed by the Blackfeet involving the use of "five flat pieces of buffalo bone, each about six inches long and three-fourths of an inch wide and tapering to blunt ends." The gaming pieces described by Ewers are incised on one side but otherwise are similar to the artifact we recovered.

Pointed Bone Fragments

These enigmatic artifacts include five long bone and three rib fragments, all presumed to be bison (Figure 110n-p). The fragments measure up to 110 mm in length and 44 mm in width. All of the specimens exhibit one sharp, angled, pointed end which has been rounded from use. Their specific function is unknown. None of the specimens is presently sharp enough to be an awl; although, such use may have produced the kind of wear exhibited by some of these specimens. All were removed from the top three levels in the block excavation.

CHAPTER 9

CONCLUDING REMARKS

The 1985/86 excavations at HSI have provided a significant look at the realm of bison butchering on the northern Plains. Although the archaeological deposits at this site suffer from a number of serious complications - principally the compression of numerous occupations into a thin soil horizon and the poor preservation of bone - there are still a number of important contributions that can be attained from analysis of this problematic assemblage.

The excavations conducted at HSI during the 1985/86 field seasons have provided a small, stratified sample of cultural material which casts some light on the temporal aspects of the changing role of bison processing at this site. The record from the processing area is markedly different from that of the kill site in that the former is composed almost exclusively of material attributable to the Late Prehistoric Period. This result itself suggests a significant shift in the use of the site between the Middle and Late Prehistoric periods.

Although the processing area contains only the end of the culture historical continuum, as documented from the kill site by Reeves (1978, 1983), the stratigraphic integrity of this shallow deposit is intact, and cultural material recovered from here conforms to Reeves' model of culture history. In other words, both Avonlea and Old Women's Phase materials are well represented, and both are in the appropriate stratigraphic position. The co-occurrence of Avonlea projectile points with pottery attributable to period 1 of the Saskatchewan Basin Complex and of Old Women's projectile points with pottery styles attributable to that of periods 2 and 3 are consistent with results obtained elsewhere on the plains (Byrne 1973). A sterile sand lens that horizontally bisects the Avonlea component in this deposit has been bracketed by radiocarbon determinations of 1,300 years B.P. and 800 years B.P. These dates can be assigned to the Avonlea and early Old Women's materials, respectively, and are in accordance with the accepted chronology for the northern Plains (Reeves 1983b; Vickers 1986).

The amount of debris deposited on the prairie level below the kill site by Late Prehistoric hunters is truly phenomenal. The bulk of our assemblage was recovered from a contiguous excavation area of 25 square metres, and almost exclusively from the top 50 cm of that area. In this small area, 6,061 pieces of fire-broken rock, weighing 1119.7 kg, 7,683 identified faunal elements, principally bison, and 15,780 lithic artifacts were recovered, as were smaller numbers of pottery (271), bone tools (23) and historical artifacts (19). It should also be recalled that thousands of small fragments of bison bones and fire-broken rock were deemed to have no analytical value and were discarded. The richness of the site is even more impressive when one considers that a similar density of material covers an estimated area of 100,000 square metres. In other words, our sample from the 1985/86 field seasons constitutes an excavation of about 0.025 percent of the total site area.

The purpose of this concluding chapter is not to review the principal discoveries of the 1985/86 field seasons at HSI; rather, we will speculate as to how some of the material remains and patterns in the analytical data might elucidate a broader picture of prehistoric events at the site and in the region of the northern Plains. By necessity, the scenarios presented below will be highly tentative. Often, there is little data with which to support the following suggestions. The intent here is to advance a number of ideas which might account for some of the more important observations we have made of the archaeological record at the HSI processing area. Among the significant questions to ponder are (1) how to partition the formative influences of both man and nature in shaping the character of the faunal record at HSI, (2) how to explain the sudden appearance of intensive bison processing on the prairie below the jump beginning about 1,800 years ago, and (3) what motivating factors were behind the need or desire to completely render the nutritional content form the bison carcasses during the past two millennia.

Because HSI is a bison kill/butchery site, it is appropriate to begin with a discussion of the faunal remains from the processing area. There is no argument that the faunal materials have suffered from severe environmental and cultural destructive forces. As a result, clarification of the taphonomy of the assemblage is exceedingly difficult. In almost every case, when an argument can be made for the cultural processing of bone, an equally convincing case can be made for the genesis of the assemblage through natural means. This dilemma begins at the very earliest analytical stage, when asking why the recovered fauna is present at the site. Can abandoned (hence archaeologically recovered) bones be regarded as discards of cultural processing and, therefore, as elements that functioned in the quest for nutrition? Are the abandoned bones the residue of a series of taphonomic agents which have included cultural modification, carnivore and insect damage, long-term exposure to climatic extremes, and other chemical and erosional forces present on and in the thin, silty soils at this site? In support of the case for cultural modification, the measures we used have demonstrated a correlation between recovered fauna and the selective behaviours of prehistoric hunters, whom we presume were interested in maximizing the return of food from the animal; that is, faunal remains generally follow predictions of what should be present and absent based on the recovery of the greatest nutritional sources. This was seen to be especially true when the analytical measures employed were based on the anatomy of bison and not on other mammals.

On the other hand, in support of non-cultural formation processes, other measures demonstrated that the faunal assemblage could have been produced largely through natural means. For example, the bones most often recovered are also those with the greatest density (based on data for deer) and, hence, the ones most likely to be preserved. As well, bones most common at the site are those more likely be ignored by other destroyers of fauna, such as carnivores and erosional forces. This includes bones with low reserves of marrow and grease, specifically carpals, tarsals, phalanges and fragments of leg bones. Bones least common, for example proximal humeri, are known to be spongy in nature, rich in grease, large in size and probably relatively low in density. The very same characteristics of the fauna which would prove attractive to man would also lead to accelerated natural destruction, and either or both could have produced the residue we find today. Unfortunately, preservation of the bone is poor, and distinguishing hallmarks of human or natural influence, such as cut marks or carnivore gnaw marks, are exceedingly rare. Thus, resolution of the genesis of the assemblage promises to be an issue requiring further thought and additional research.

Despite the uncertainty expressed above, an argument can be made that taphonomic factors, while undoubtedly important at the site, have not played the major role in shaping the character of the archaeological assemblage. The crux of the argument is that the evidence for intensive bison processing at HSI is so convincing as to suggest that the faunal remains already had been severely reduced, probably to much their present form, before adverse taphonomic agents began to affect the data. By the time the latter occurred, the faunal assemblage was largely, although not entirely, in a state which would resist most forms of natural deterioration. This argument involves consideration of the entire suite of artifactual materials.

Given the context of the fauna, it is certainly tempting to attribute the materials, and the patterns in these materials, to human action. The bones do not occur in a vacuum; rather they are recovered from amongst a massive record of intensive, long-term use of the prairie below the kill at HSI. Spanning an area of many hectares, the processing site, if viewed in its totality, would comprise millions of lithic items, including hundreds of thousands of stone tools; countless hearths, boiling pits, roasting pits and other features; millions of fragments of bison bones; and an estimated thousands of tonnes of fire-broken rock. The latter is particularly impressive and potentially instructive, especially when we consider that the vast majority of this material has been hauled from sources at least several kilometres away. From our relatively small block excavation area (25 m^2), we recovered over 6,000 pieces of fire-broken rock, weighing about 1,200 kg. These figures are not anomalous. Previous work at the site has documented similar frequencies and densities over a large region (Brink et al. 1985, 1986). Even accounting for lower densities of FBR in the more peripheral regions of the processing area, we estimate that the entire site might contain about 4 million kilograms of this material. We believe that there are some important clues here as to the function of the processing site and, hence, to the formation of the assemblage.

The imported, non-local rock types which show evidence of thermal fracture have only one known major purpose - to be used as stones to boil water in subsurface pits or in above-ground cooking vessels made from hide supported on a tripod. If this is true, then it is a testimony to the great importance of cooking or food preparation at the HSI processing area. It can be argued, in fact, that this was the single most dominant activity across the processing area. As has been discussed, cooking in pits or in hide containers could have been done to prepare stews or soups for immediate consumption. It is believed, however, that this need would not explain the sheer volume of materials recovered which pertain to stone boiling activities. We question if prehistoric hunters would transport river cobbles, in the amounts indicated, for the primary purpose of preparing meals during the several days of bison butchering and processing.

Instead, we feel that the rendering of bone grease in subsurface pits (and, less likely, in above ground hide vessels) is a more likely explanation for the great wealth of fire-broken rock, features and related artifacts recovered from the site. This grease rendering is believed to be an integral part of the production of pemmican, since it seems to be the fats rendered from bones, rather than other forms of body fat, that are more often mixed with the dried meat (see Reeves 1989; Verbicky-Todd 1984). Of course, efficient grease rendering requires relatively complete reduction of those elements most noted for their grease content (Binford 1978; Leechman 1951; Vehik 1977). Bones rich in grease will be fragmented into a condition where the elements cannot be identified and, hence, will be absent from the archaeological record or identified only as small portions of the former element. Bones which are low in grease content will be ignored and will be recovered in more complete form and in greater abundance. The analysis of faunal remains from the 1985/86 field seasons has shown that the recovered element frequencies, and what is known or suspected of the grease content of these elements, are in accordance with expectations based on bone grease rendering.

Thus, through an admittedly circuitous route of reasoning it can be argued that the abundance of fire-broken rock, hearths and subsurface pits, the wealth of broken bone, and the relative proportions of the different skeletal elements from the bison carcasses, can be accounted for by the intensive and persistent use of the processing area in the production of pemmican. The bulk of evidence recovered from the HSI processing area points to an overwhelming concern with on-site cooking, most likely, we believe, to extract bone grease. This activity would yield an archaeological residue very similar to that recovered from the site. Subsequent taphonomic agents would have been operating on an assemblage already reduced to precisely those elements least likely to be adversely affected. None of the recovered data conflict with this scenario. Yet it is also clear that we have not eliminated the possibility that natural processes have conspired to mimic the actions of prehistoric hunters.

One of the most interesting questions posed by the juxtaposition of the archaeological records from the HSI kill and processing area is the near absence of Middle Prehistoric material in the latter region. If, as suggested, a critical function of the prairie level was for the production of pemmican and, more generally, the production of other forms of storable foods, then it is implied that the full utilization of the bison carcass, including the labour intensive bone grease rendering, is a phenomenon of the Late Prehistoric Period, at least at HSI. Yet it seems clear that the relatively sudden appearance of intense bison processing, especially bone grease rendering, does not mark the initial discovery of the technique of pemmican making; Reeves (1989) puts the date of this invention at nearly 5,000 years B.P. on the northern Plains. If this estimate is correct, the knowledge of how to process bison meat and fat for long-term storage was available to the prehistoric hunters for nearly 3,000 years before it showed up as an important feature of the archaeological record at HSI.

Since we have no radiocarbon-dated materials from the processing area that pre-date about 2,000 years B.P., and only a handful of diagnostic projectile points that may date to an earlier period, it is suggested that the users of the jump between about 5,700 and 2,000 years B.P. were engaged in a very different kind of butchering and processing than were the later occupants. Unfortunately, from our vantage point on the prairie we are unable to test this proposition. Our faunal record from 1985/86 reveals no apparent changes in the utilization of bison over the past 2,000 years; and, since our record does not extend beyond this time period, we cannot investigate the possibility that earlier users of the jump behaved in markedly different ways. Evaluation of the differing butchering techniques and the extent of carcass utilization between Middle and Late Prehistoric times will require a detailed comparison of the kill and processing area faunal remains, a task beyond the scope of this report. The paucity of cultural material at the processing site which dates to the earlier time periods does indicate different site utilization between the Middle and Late Prehistoric uses of the site, however. This argument assumes, of course, that our sampling and testing of the lower prairie has not missed an area where the earlier cultures did indeed intensively process bison carcasses. We feel confident that no such area has been overlooked.

What scant evidence we do have of a Middle Prehistoric use of the processing area occurs as a thin scatter of lithic artifacts, predominantly debitage, and a few bison bones which tend to be relatively more complete than the later fauna. Both of these observations point to infrequent and short-term visitation of this area. Lithic artifacts are derived consistently from the maintenance of apparently curated tools. On-site manufacture of lithic tools in the processing area is rare during this time period. This pattern of lithic utilization changes radically with the appearance of the Avonlea component in the processing area. Not only does the quantity of lithic material increase dramatically, but the nature of the assemblage changes, in that all stages of lithic reduction are well represented. Tool varieties are diverse; they include the extractive tools requisite for butchering and processing animals, which were now being frequently produced on site, and the maintenance tools, indicative of a broad spectrum of activities associated with a longer term occupation of this particular site area. This pattern of lithic utilization persists through the Old Women's component.

Why the relatively abrupt appearance of evidence for intensive bison processing, especially in light of the fact that the same jump had been in use for 4,000 years prior to this appearance? While we are not yet able to answer this question, several suggestions can be advanced.

It is logical to assume that much of the yield from a successful bison drive would be used by the participants and their immediate contacts. It can also be suggested that very successful jumps typically overproduced. With an 11 m deep bone bed, spanning 5,700 years, and a beautifully situated gathering basin capable of producing enough bison for a drive at almost any time, it is possible that HSI was one of few jumps which possessed the potential to kill bison in numbers well beyond that required by the resident populations. Yet, surplus spoils are of no value unless preserved. The manufacture of pemmican enabled the generation of a storable surplus of meat and fat. Frison (1978) is no doubt correct in noting that communal bison kills likely produced supplies intended to last the participating groups through the winter months. Reeves (1989) has noted the advantage to putting away stored bison foods during the spring to allow groups the opportunity to gather for communal summer activities, such as the sun dance, without the need for continuous procurement of fresh meat, but the most successful jumps could have exceeded these demands.

Surplus bison materials, especially those preserved in a form suitable for long-term consumption, could have been a valuable trade item. Any groups located in areas less endowed with efficient mechanisms for killing large numbers of bison, or generally in need of larger food stores or bison by-products, may have been inclined to bring in some of the by-products of the buffalo through trade. This likely would have included dried hides and meat prepared in the form of dried jerky or pemmican.

Thus, an intriguing but currently unsupportable possibility is that the intensification of bison processing at HSI, beginning about 2,000-1,800 years ago, represents the participation of peoples of this area in an extensive trade network. During the early use of the jump, and in the absence of a well-developed bison trade network, there would have been an abundance of food supplies for the local participants, hence little need to engage in the labour intensive rendering of all potential food sources in the carcass. Primary butchering was done at the kill site, and the spoils were hauled away from this location to a more permanent camp. If the inception of trade networks provided a market for additional supplies from bison kill sites then greater utilization of the carcasses may have ensued. This effect would be noticed more at the most effective jumps, such as HSI, where the hunters had good reason to believe that their efforts would prove successful. Reeves (1989) has postulated that for much of the Middle Prehistoric Period, up until about 3,000 years B.P., trade networks were quite restricted on the northern Plains. This changes in the latter part of the Middle Prehistoric Period and continues during the Late Prehistoric Period, when extensive trade networks are complex and extensive (Reeves 1989).

Johnson (1986) has suggested that a number of Late Prehistoric Period sites in western Minnesota, part of the Cambria Phase, were participants in trade networks involved in supplying dried bison hides and bison meat to the Cahokia center. In return, he suggests that the mixed horticultural/bison hunting cultures of Minnesota received dried maize and possibly tobacco and other cultigens (Johnson 1986). Johnson also believes that this trade was not limited to the Cambria Phase cultures but was, in fact, common to other groups in the western part of the state. It is conceivable that the tentacles of the Cahokia trade network may have reached far into the northern Plains. It is not unreasonable to suggest that HSI may have played an important role in trading bison materials, especially considering the evident success of this particular jump compared to most others.

What was traded back to the HSI region in return for bison supplies? Certainly tobacco may well have been imported in a prepared form. Other cultigens may also have been involved in the trade network. Speth (1983) and Speth and Spielmann (1983) have raised the argument that basic biological dietary requirements may have precipitated certain exchange patterns throughout parts of central North America. The details of the argument involving protein metabolism and the propensity of certain food groups to promote or hinder protein sparing, which is required for retention of nitrogen in diets composed primarily of meat - are complex and can be found in the sources cited above. For our purposes it is sufficient to note that the need for carbohydrate content in the diet of hunters and gatherers may have promoted exchange of bison materials (hides, fat, meat) for plant foods rich in carbohydrate. This would especially be true of hunting cultures living in regions where there was a relative scarcity of carbohydrate-rich wild plants foods (Speth 1983). The northern Plains would constitute a carbohydrate-poor region. Thus, it is possible that the intensification of bison processing seen at HSI, beginning around 2,000 years ago, arose in response to a desire to trade bison materials (including but not limited to foods) in exchange for plant foods from regions further south.

Trade networks out of the HSI area would have certainly involved many "middle men," quite possibly in the Upper Missouri region. Of course, the archaeological record from HSI is not the ideal place to examine the question of reverse trade. Activity specific sites, such as a bison kill, will not contain a representative sample of material culture. Local camp sites in the HSI region would be more likely places to recover traded items. If cultigens were traded into the HSI region, the use of careful recovery techniques, as well as favourable preservation conditions, would be required to produce evidence of these materials. Nevertheless, other items of material culture, specifically certain lithic types, may also have played an important role in a long distance trade network. As excavations at the

HSI processing area have yielded a large sample of exotic lithic materials, we can address the issue of trade from this perspective.

The fine quality lithic raw material required to fashion formed tools, particularly projectile points, is not available in the vicinity of HSI. It is estimated that hundreds of thousands of arrowheads were lost or discarded at HSI. Although arrowheads are regarded as curated tools in the sense that they may have been transported considerable distances before being used, arrowheads are short-lived tools that would have required frequent replacement. As demands for such replacement materials could not be met locally, frequent visitation to distant source locations, or alternatively trade, would have been required to satisfy this need.

Based on their excavations at the Vore site, Reher and Frison (1980) argue that trade was not an important means of obtaining lithic material on the plains. While this may be true for the Wyoming area, clearly it is not applicable to the HSI region. Although hunter-gatherers have been demonstrated to be capable of covering enormous distances in order to procure resources, no precedent suggests that the users of HSI would cover the requisite distance just to obtain Knife River Flint from North Dakota or obsidian from the Yellowstone area, nor is it likely that such groups would be permitted free access to such quarries. We feel that trade must have played a role in the acquisition of lithic raw materials used at HSI. The results from the analysis of lithic material from the processing area indicate an increase in the use of exotic lithic materials during the Old Women's Phase, including an increase in the use of Knife River Flint, Yellowstone obsidian and Madison Formation cherts.

It is even possible that technology, rather than simply raw materials, was the object of trade. Well-made, triangular arrowhead preforms that apparently were made elsewhere occur at the site in a notch-ready state. These are most prevalent with the Avonlea occupation that heralds the introduction of the use of the bow and arrow at this site. It can be speculated that these artifacts were the product of craft specialists who may have played an important role in the distribution of bow and arrow technology and maintained that role either by providing a superior product or by restricting access to quarries. Avonlea projectile points are arguably the finest crafted arrowheads ever made. This, and the often noted consistency in the form of these arrowheads, supports the argument for manufacture by specialists. In contrast, relative to Avonlea points, the Old Women's materials are noted for their poor quality of manufacture and wide variability in form - both traits associated with manufacture by many peoples of differing capabilities. Reeves (1989) has recently made similar observations of these two Late Prehistoric Period point types. Our data indicate that, at HSI, the gradual reduction in the importation of finely crafted, Avonlea preforms is coincident with an increase in the importation of exotic raw materials during the Old Women's Phase.

Thus, it can be suggested that, during Avonlea times, the users of HSI participated in a network of trade which saw, among other things, the import of preformed artifacts, specifically Avonlea points, and the export of preserved bison materials obtained through communal kills. Later, at the onset of the Old Women's period, trading of specially crafted preforms deteriorated (for reasons unknown), necessitating the import of raw materials for local point manufacture. The paucity of quality stone in the HSI region dictated that, at least some of these raw materials, would have come from distant sources, such as Knife River and Yellowstone. Again, the materials traded in return for the exotic lithic types would have been surplus spoils from the communal kills. The need for preserved bison supplies as an object of trade thus continued throughout the Avonlea and Old Women's phases, or for about the past 1,600 years. This coincides with the age of nearly all the bison processing remains found at HSI. At present, this scenario is largely speculation.

Other factors may account for the intensification of bison processing seen at HSI in the past two millennia. For example, a trend towards increased sedentism would enable the transport and storage of the massive amounts of surplus foods that a typical jump would yield. If Frison (1970, 1974) is correct and an average bison jump involved several hundred animals, and if the herds were mainly cow/calf groups where the average animal weighed 400 kg, and if prehistoric processing resulted in the recovery of about 60 percent of the live weight of the animal, this yields about 40,000 kg of useable foods (not including hides and bones) from an average kill. This is a huge reserve for any nomadic group to contend with; regular movement with any such supply would be out of the question. Logically, the materials would be moved to a nearby, semi-permanent camp. From here, materials could be consumed, traded or both. In fact, it may be that the large camps to which the spoils were hauled (and which we believe exist in the valley of the Oldman River some 2 km from Head-Smashed-In) could serve as bases to which others, not directly involved in the kill, might travel to obtain food. Such a strategy might mimic that employed by the early mammoth hunters who, apparently, moved to the location of a fresh kill rather than attempt to haul the mammoth remains any great distance. The most successful jumps, as HSI clearly was, may have both dictated and fostered a modicum of sedentism, at least for a portion of the yearly round.

Population increases likewise would create the demand for more food resources extracted from the kills and can also be viewed as a causal agent in the increase towards more intensive processing. Reeves (1989) has speculated that a substantial population increase accompanied the onset of the Late Prehistoric Period. It is just as possible that population increases in the Late Prehistoric Period were the central cause behind the extraction of more food resources from the kill, that the groups working the jump needed and consumed virtually all of the spoils of the kill, and that little or no bison materials were traded away from the region. At present, it is somewhat frustrating that a number of conflicting scenarios exists which can account for the rise in the importance of intensive bison processing. However, some consolation can be taken from the fact that, in all the above cases, archaeological correlates can be posited and sought out in order to explain the apparent rapid and dramatic increase in the extent to which bison were utilized at HSI. Substantiating a cause for the rise of intensive bison processing will be one goal of future research at HSI.

In conclusion, it is apparent that our research at the processing area of HSI has generated much data, raised many questions and supplied few firm answers. The latter is to be expected. The dearth of research at butchering areas associated with the communal Plains bison kill sites is such that our understanding of the human behaviours which transpired at these activity-specific sites remains in its infancy. Continued research at HSI alone will not rectify this situation. More butchery/processing assemblages from a broader geographic region need to be examined. Especially important is the need to conduct detailed comparisons between the faunal and lithic components of associated kill and processing areas. Many suggestions made here to account for patterns perceived in the HSI processing area are contingent upon the nature of the reciprocal data sets from the kill. While data from Reeves' HSI kill site excavations are available, the magnitude of a comparison of data from the two regions is beyond the scope of this report. Clearly, however, for major progress to be made in the fuller understanding of the most vital aspect of prehistoric Plains Indian economy - the great communal bison kills - just such undertakings are required.

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APPENDICES

APPENDIX 1
NISP, DkPj-1
1985/86 BLOCK EXCAVATION AREA
FEATURES INCLUDED, BULK REMOVED

CODE No.	ELEMENT	FREQ	CODE No.	PORTION	FREQ
3	skull	137	1	complete	0
			2	calvaria	3
			3	nasal	3
			4	maxilla	12
			5	basio-occip	11
			6	eye-orbit	4
			7	petrous	86
			8	tooth row	10
			9	horn core	8
			10	n/a	0
4	mandible	119	1	complete	1
			2	coronoid	18
			3	proximal	18
			4	midsection	59
			5	distal	15
			6	n/a	8
5	hyoid	1	1	complete	0
			2	great cornu	1
			3	shaft	0
			4	n/a	0
6	atlas	7	1	complete	0
			2	centrum	4
			3	vert projection	2
			4	n/a	1
7	axis	5	1	complete	1
			2	centrum	4
			3	vert projection	0
			4	n/a	0
8	cervical vert	40	1	complete	2
			2	centrum	26
			3	vert projection	10
			4	n/a	2
9	thoracic vert	93	1	complete	0
			2	centrum	28
			3	vert projection	75
			4	n/a	0
10	lumbar vert	42	1	complete	0
			2	centrum	21
			3	vert projection	19
			4	n/a	2
11	sacrum	10	1	complete	0
			2	centrum	4
			3	vert projection	4
			4	body	2
			5	n/a	0
12	caudal vert	9	1	complete	1
			2	centrum	6
			3	vert projection	0
			4	n/a	2
13	rib	242	1	complete	0
			2	head	58
			3	body	183
			4	costal cart	1
			5	n/a	3
14	sternabra	1		n/a	
15	pelvis	140	1	complete	0
			2	ilium	19
			3	acetabulum	103
			4	pubis	1
			5	ischium	10
			6	n/a	7

APPENDIX 1 CONTINUED:
NISP, DkPj-1
1985/86 BLOCK EXCAVATION AREA
FEATURES INCLUDED, BULK REMOVED

CODE No.	ELEMENT	FREQ	CODE No.	PORTION	FREQ
16	scapula	181	1	complete	1
			2	glenoid cavity	79
			3	crest	23
			4	anterior border	22
			5	blade	51
			6	n/a	5
17	humerus	236	1	complete	0
			2	proximal end	21
			3	distal end	146
			4	shaft	68
			5	n/a	1
18	radius	377	1	complete	0
			2	proximal end	181
			3	distal end	137
			4	shaft	53
			5	n/a	6
19	ulna	222	1	complete	0
			2	proximal end	150
			3	distal end	17
			4	shaft	49
			5	n/a	6
20	scaphoid	125		n/a	
21	lunate	110		n/a	
22	cuneiform	111		n/a	
23	pisiform	27		n/a	
24	magnum	103		n/a	
25	unciform	99		n/a	
26	5th metacarpal	9		n/a	
37	metacarpal	234	1	complete	8
			2	proximal end	136
			3	distal end	81
			4	shaft	7
			5	n/a	1
27	femur	167	1	complete	0
			2	proximal end	55
			3	distal end	16
			4	shaft	93
			5	n/a	1
28	patella	79		n/a	
29	tibia	387	1	complete	0
			2	proximal end	37
			3	distal end	175
			4	shaft	159
			5	n/a	16
30	lateral malleolus	85		n/a	
31	astragalus	270		n/a	
32	calcaneus	221		n/a	
33	navicular cuboid	162		n/a	
34	cuneiform pes	132		n/a	
35	1st tarsal	16		n/a	
36	2nd tarsal	11		n/a	
38	metatarsal	231	1	complete	0
			2	proximal end	127
			3	distal end	94
			4	shaft	7
			5	n/a	3
40	1st phalanx	536		n/a	
41	2nd phalanx	528		n/a	
42	3rd phalanx	261		n/a	
43	proximal sesamoid	172		n/a	
44	distal sesamoid	93		n/a	

APPENDIX 1 CONTINUED:
NISP, DkPj-1
1985/86 BLOCK EXCAVATION AREA
FEATURES INCLUDED, BULK REMOVED

CODE No.	ELEMENT	FREQ	CODE No.	PORTION	FREQ
67	upper tooth	90		n/a	
68	incisor/canine	61		n/a	
69	lower mol/pre	62		n/a	
39	metapodial	328	1	complete	0
			2	proximal end	57
			3	distal end	192
			4	shaft	69
			5	n/a	10
60	longbone fragment	244		n/a	
63	costal cart	4		n/a	
64	scapula cart	1		n/a	
65	skull fragment	45		n/a	
66	tooth fragment	39		n/a	
70	rib fragment	149		n/a	
71	vert fragment	79		n/a	
75	pes/manus	1		n/a	
99	unknown	12		n/a	

Total Count	7146
Minus fragments	902
NISP	6244

APPENDIX 3
FAUNAL RECORD, DkPj-1
1985/6 EXCAVATION, COMPLETE PORTIONS ONLY (MNE)
FEATURES INCLUDED

CODE #	ELEMENT	FREQ	CODE #	PORTION	FREQ
3	skull	39	1	complete	0
			2	calvaria	0
			3	nasal	0
			4	maxilla	2
			5	basio-occipital	0
			6	eye-orbit	0
			7	petrous	37
			8	tooth row	0
			9	horn core	0
			10	n/a	0
4	mandible	7	1	complete	1
			2	coronoid	1
			3	proximal	0
			4	midsection	3
			5	distal	2
			6	n/a	0
5	hyoid	1	1	complete	0
			2	great cornu	1
			3	shaft	0
			4	n/a	0
6	atlas	1	1	complete	0
			2	centrum	1
			3	vert projection	0
			4	n/a	0
7	axis	1	1	complete	1
			2	centrum	0
			3	vert projection	0
			4	n/a	0
8	cervical vert	10	1	complete	2
			2	centrum	6
			3	vert projection	2
			4	n/a	0
9	thoracic vert	1	1	complete	0
			2	centrum	1
			3	vert projection	0
			4	n/a	0
10	lumbar vert	4	1	complete	0
			2	centrum	4
			3	vert projection	0
			4	n/a	0
11	sacrum	2	1	complete	0
			2	centrum	1
			3	vert projection	1
			4	body	0
			5	n/a	0
12	caudal vert	2	1	complete	1
			2	centrum	1
			3	vert projection	0
			4	n/a	0
13	rib	12	1	complete	0
			2	head	11
			3	body	1
			4	costal cart	0
			5	n/a	0
14	sternabra	0		n/a	
15	pelvis	4	1	complete	0
			2	ilium	0
			3	acetabulum	4
			4	pubis	0
			5	ischium	0
			6	n/a	0

APPENDIX 2 CONTINUED:
FAUNAL RECORD, DkPj-1
1985/6 EXCAVATION, COMPLETE PORTIONS ONLY (MNE)
FEATURES INCLUDED

CODE #	ELEMENT	FREQ	CODE #	PORTION	FREQ
16	scapula	27	1	complete	1
			2	glenoid cavity	23
			3	crest	0
			4	anterior bord	0
			5	blade	3
			6	n/a	0
17	humerus	24	1	complete	0
			2	proximal end	1
			3	distal end	23
			4	shaft	0
			5	n/a	0
18	radius	105	1	complete	0
			2	proximal end	55
			3	distal end	48
			4	shaft	2
			5	n/a	0
19	ulna	6	1	complete	0
			2	proximal end	5
			3	distal end	0
			4	dist end	1
			5	n/a	0
20	scaphoid	86		n/a	
21	lunate	72		n/a	
22	cuneiform	69		n/a	
23	pisiform	24		n/a	
24	magnum	85		n/a	
25	unciform	70		n/a	
26	5th metacarp	7		n/a	
37	metacarpal	101	1	complete	8
			2	proximal end	46
			3	distal end	47
			4	shaft	0
			5	n/a	0
27	femur	6	1	complete	0
			2	proximal end	5
			3	distal end	0
			4	shaft	1
			5	n/a	0
28	patella	26		n/a	
29	tibia	94	1	complete	0
			2	proximal end	2
			3	distal end	88
			4	shaft	4
			5	n/a	0
30	lateral malleolus	62		n/a	
31	astragalus	158		n/a	
32	calcaneus	50		n/a	
33	navicular cuboid	97		n/a	
34	cuneiform pes	105		n/a	
35	1st tarsal	13		n/a	
36	2nd tarsal	11		n/a	
38	metatarsal	103	1	complete	0
			2	proximal end	43
			3	distal end	59
			4	shaft	1
			5	n/a	0
40	1st phalanx	282		n/a	
41	2nd phalanx	309		n/a	
42	3rd phalanx	156		n/a	
43	proximal sesamoid	139		n/a	
44	distal sesamoid	81		n/a	
67	upper tooth	27		n/a	
68	incisor/canine	21		n/a	
69	lower mol/pre	21		n/a	

Total Count	2521
Minus teeth	69
Total MNE	2452

APPENDIX 3
NISP, DkPj-1
1985 SPRING CHANNEL
BULK REMOVED

CODE No.	ELEMENT	FREQ	CODE No.	PORTION	FREQ
3	skull	86	1	complete	0
			2	calvaria	5
			3	nasal	3
			4	maxilla	10
			5	basio-occip	33
			6	eye-orbit	2
			7	petrous	22
			8	tooth row	0
			9	horn core	11
			10	n/a	0
4	mandible	29	1	complete	5
			2	coronoid	4
			3	proximal	8
			4	midsection	6
			5	distal	4
			6	n/a	2
5	hyoid	3	1	complete	1
			2	great cornu	2
			3	shaft	0
			4	n/a	0
6	atlas	7	1	complete	2
			2	centrum	3
			3	vert projection	2
			4	n/a	0
7	axis	9	1	complete	4
			2	centrum	5
			3	vert projection	0
			4	n/a	0
8	cervical vert	44	1	complete	20
			2	centrum	21
			3	vert projection	3
			4	n/a	0
9	thoracic vert	31	1	complete	11
			2	centrum	13
			3	vert projection	7
			4	n/a	0
10	lumber vert	25	1	complete	8
			2	centrum	11
			3	vert projection	5
			4	n/a	1
11	sacrum	5	1	complete	0
			2	centrum	1
			3	vert projection	2
			4	body	2
			5	n/a	0
12	caudal vert	3	1	complete	2
			2	centrum	1
			3	vert projection	0
			4	n/a	0
13	rib	36	1	complete	4
			2	head	21
			3	body	10
			4	costal cart	1
			5	n/a	0
14	sternabra	0		n/a	
15	pelvis	34	1	complete	0
			2	ilium	7
			3	acetabulum	26
			4	pubis	0
			5	ischium	1
			6	n/a	0

APPENDIX 3 CONTINUED:
NISP, DkPj-1
1985 SPRING CHANNEL
BULK REMOVED

CODE No.	ELEMENT	FREQ	CODE No.	PORTION	FREQ
16	scapula	19	1	complete	6
			2	glenoid cavity	12
			3	crest	0
			4	anterior border	1
			5	blade	0
			6	n/a	0
17	humerus	9	1	complete	1
			2	proximal end	0
			3	distal end	7
			4	shaft	1
			5	n/a	0
18	radius	9	1	complete	1
			2	proximal end	2
			3	distal end	5
			4	shaft	1
			5	n/a	0
19	ulna	2	1	complete	0
			2	proximal end	2
			3	distal end	0
			4	shaft	0
			5	n/a	0
20	scaphoid	3		n/a	
21	lunate	5		n/a	
22	cuneiform	3		n/a	
23	pisiform	1		n/a	
24	magnum	6		n/a	
25	unciform	2		n/a	
26	5th metacarpal	0		n/a	
37	metacarpal	8	1	complete	4
			2	proximal end	0
			3	distal end	4
			4	shaft	0
			5	n/a	0
27	femur	10	1	complete	0
			2	proximal end	3
			3	distal end	6
			4	shaft	1
			5	n/a	0
28	patella	3		n/a	
29	tibia	17	1	complete	1
			2	proximal end	6
			3	distal end	7
			4	shaft	3
			5	n/a	0
30	lateral malleolus	1	0	n/a	
31	astragalus	10	0	n/a	
32	calcaneus	7	0	n/a	
33	navicular cuboid	4	0	n/a	
34	cuneiform pes	0	0	n/a	
35	1st tarsal	0	0	n/a	
36	2nd tarsal	0	0	n/a	
38	metatarsal	5	1	complete	1
			2	proximal end	1
			3	distal end	1
			4	shaft	2
			5	n/a	0
40	1st phalanx	14		n/a	
41	2nd phalanx	18		n/a	
42	3rd phalanx	5		n/a	
43	proximal sesamoid	4		n/a	
44	distal sesamoid	0		n/a	

APPENDIX 3 CONTINUED:
NISP, DkPj-1
1985 SPRING CHANNEL
BULK REMOVED

CODE No.	ELEMENT	FREQ	CODE No.	PORTION	FREQ
67	upper tooth	23		n/a	
68	incisor/canine	3		n/a	
69	lower mol/pre	24		n/a	
39	metapodial	5	1	complete	0
			2	proximal end	1
			3	distal end	4
			4	shaft	0
			5	n/a	0
60	longbone fragment	0		n/a	
63	costal cart	0		n/a	
64	scapula cart	0		n/a	
65	skull fragment	1		n/a	
66	tooth fragment	0		n/a	
70	rib fragment	0		n/a	
71	vert fragment	4		n/a	
75	pes/manus	0		n/a	
99	unknown	0		n/a	
	Total Count	537			
	Minus Fragments	10			
	NISP	527			

APPENDIX 4

PROJECTILE POINT DATA

All metric and non-metric attributes recorded for projectile points recovered from the 1985 and 1986 field seasons at HSI have been provided below. Attributes of non-identifiable projectile point fragments are not included in this list. The methodology used was the same as that used for the analysis of materials recovered during the 1983 and 1984 field seasons (Brink *et al.* 1985). The method for obtaining metric measurements is illustrated in Figure 111. This is followed by a description of the non metric attribute codes used in the data table.

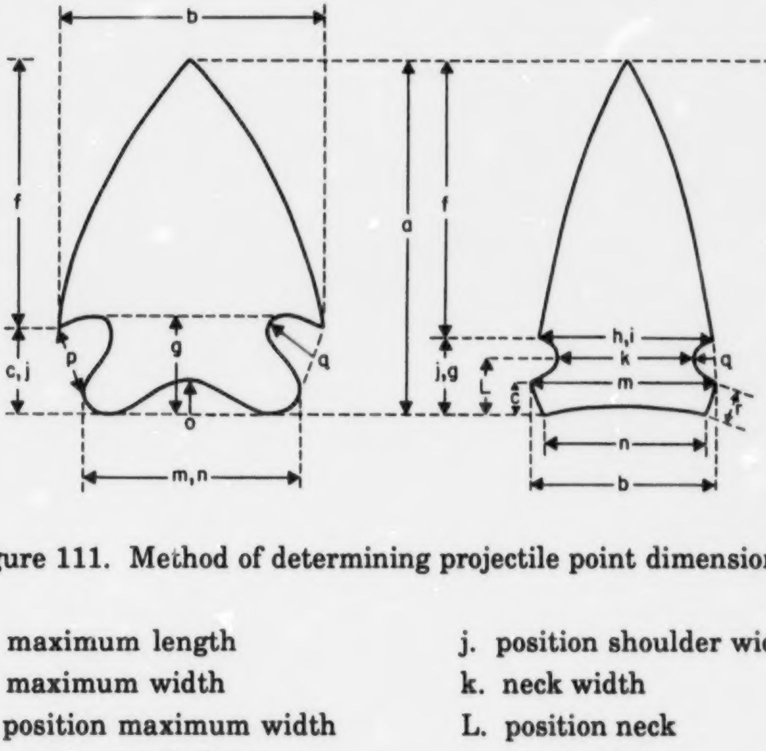

Figure 111. Method of determining projectile point dimensions.

a. maximum length
b. maximum width
c. position maximum width
d. maximum thickness
e. position maximum thickness
f. blade length
g. stem length
h. blade width
i. shoulder width

j. position shoulder width
k. neck width
L. position neck
m. stem width
n. base width
o. basal notch depth
p. notch breadth
q. notch depth
r. proximal-lateral edge height

INTEGRITY: 0: indeterminate fragment. 1: complete. 2: complete except distal tip. 3: distal tip and part of blade missing. 4: base or base fragment. 5: blade intact, part of base missing. 6: midsection only. 7: tip only. 8: lateral segment. 9: tip and part of base missing.

LONGITUDINAL CROSS SECTION: 0: indeterminate, incomplete. 1: biconvex/lenticular. 2: biplano. 3: plano-convex. 4: concavo-convex/concavo-triangular. 5. convexo-triangular. 6: plano-triangular. 7: diamond. 8: wedge. 9: other.

TRANSVERSE CROSS SECTION:
same codes as for Longitudinal Cross Section above.

BLANK TYPE: 0: indeterminate/obscured. 1: flake, ventral face present. 2: flake, ventral and dorsal faces present. 3: flake, ventral and dorsal faces indeterminate/indistinguishable. 4: cortical flake, less than half of one face is cortex. 5: spall, most of one face is cortex. 6: pebble, both faces have cortex. 7: bipolar pebble fragment, two opposing platforms. 8: tabular slab, dorsal and/or ventral surface is a bedding or jointing plane. 9: other.

BLANK ORIENTATION: 0: indeterminate/obscured. 1: longitudinal, platform proximal. 2: longitudinal, platform distal. 3: longitudinal, platform missing/bipolar. 4: transverse, platform on one lateral side. 5: transverse, bipolar. 6: oblique, platform at proximal lateral. 7: oblique, platform at distal lateral. 8: oblique, platform missing/bipolar. 9: other.

FLAKING TYPE OBVERSE: 0: indeterminate, blade absent. 1: parallel. 2: expanding. 3: contracting. 4: oval-ovate. 5: irregular. 6: marginal. 7: bimodal. 8: indeterminate/indistinct. 9: no retouch/not applicable.

FLAKING PATTERN OBVERSE: 0: indeterminate, blade absent. 1: non patterned. 2: transverse bilateral. 3: bidirectional, oblique. 4: bidirectional, oblique and transverse. 8: indistinct. 9: no retouch/not applicable.

FLAKING TYPE REVERSE:
same codes as for Flaking Type Obverse above.

FLAKING PATTERN REVERSE:
same codes as for Flaking Pattern Obverse above.

BLADE EDGE 1 SHAPE: 0: indeterminate absent. 1: straight. 2: convex. 3: concave. 4: recurved. 5: proximally skewed convex. 6: distally skewed convex. 7: angular. 9: irregular/other.

BLADE 1 MORPHOLOGY: 0: absent/indeterminate. 1: straight even/double bevel. 2: sinous. 3: serrated (straight). 4: straight single bevel. 5: curved double bevel. 6: curved single bevel. 7: other. 8: broken. 9: irregular.

BLADE EDGE 2 SHAPE:
same codes as for Blade Edge 1 Shape above.

BLADE EDGE 2 MORPHOLOGY:
same codes as for Blade Edge 1 Morphology above.

SHOULDER SHAPE 1: 0: indeterminate/absent. 1: square angular. 2: square rounded. 3: obtuse angular. 4: obtuse rounded. 5: acute angular (barbed). 6: acute rounded. 8: irregular. 9: not applicable.

SHOULDER SHAPE 2:
same codes as for Shoulder Shape 1 above.

EDGE GRINDING: 0: indeterminate. 1: base edge only. 2: base and stem. 3: base, stem, and shoulder. 4: stem and shoulders. 5: stem only. 6: notches only. 7: notches and base. 8: other. 9: no grinding apparent.

BASE SHAPE: 0: indeterminate/missing. 1: straight. 2: convex. 3: concave. 4: notched. 5: V-shaped. 6: gull wing. 7: trivectoral. 8: irregular. 9: other.

BASAL THINNING: 0: indeterminate. 1: none present. 2: marginal unifacial. 3: marginal bifacial. 4: extensive unifacial, multiple scars. 5: extensive bifacial, multiple scars. 6: extensive/marginal, multiple scars. 7: single extensive/marginal. 8: single extensive/extensive multiple. 9: other.

NOTCH 1 SHAPE: 0: indeterminate absent. 1: square or rectangular. 2: U-shape. 3:semicircular. 4: parabolic. 5: angular expanding. 6: crescentic. 7: rounded V. 8: irregular/other. 9: not applicable.

NOTCH 1 ORIENTATION: 0: indeterminate/absent. 1: transverse. 2: oblique proximally trending. 3: oblique distally trending. 8: irregular. 9: not applicable.

NOTCH 2 SHAPE:
same codes as for Notch 1 Shape above.

NOTCH 2 ORIENTATION:
same codes as for Notch 2 Orientation above.

NOTCHING TECHNIQUE: 0: indeterminate/absent. 1: bifacial bilateral. 2: bifacial/unifacial. 3: unifacial bilateral. 4: alternate unifacial right. 5: alternate unifacial left. 6: bifacial unilateral. 7: unifacial unilateral. 8: irregular. 9: not applicable.

PROXIMAL-LATERAL EDGE JUNCTURE 1: 0: indeterminate/absent. 1: parallel. 2: expanding. 3: contracting. 4: angular. 5: sharp. 6: blunt. 7: eared. 8: tabular. 9: other irregular.

PROXIMAL -LATERAL EDGE JUNCTURE 2:
same codes as for Proximal-Lateral Edge Juncture1 above

TIP MORPHOLOGY: 0: indeterminate/absent. 1: sharp. 2: blunt. 3: rounded/worn. 4: snapped excurvate. 5: snapped incurvate. 6: impact fractured. 7: truncated. 8: other. 9: irregular.

WEAR TYPE: 0: indeterminate/absent. 1: rounding. 2: nibbling/microflaking. 3: longitudinal striations and rounding. 4: transverse striations and rounding. 8: complex wear, wear is suggestive of multiple uses. 9: other.

WEAR LOCATION: 0: indeterminate/absent. 1: unilateral. 2: bilateral. 3: distal. 4: proximal. 5: unilateral and distal. 6: bilateral and distal. 7: medial, wear occurs on an edge formed by a tranverse fracture surface. 8: medial-lateral, wear occurs on the juncture between a lateral edge and a tranverse fracture surface. 9: other.

HEAT TREATMENT: 0: absent. 1: discoloration attributed to heat. 2: lustre attributed to heat. 3: colour and lustre attributed to heat. 4: potlidded. 5: firebroken. 6: crazed. 7: multiple heat damage, any combination of 1 to 6 above. 8: only one fragment of a refit artifact has been altered. 9: indeterminate.

OLD WOMEN'S

CATALOGUE NUMBER	61000	61002	61005	61019	61020	61021	61030	61035	61193	61233	61474
UNIT	39	39	39	40	40	40	40	40	41	41	41
LEVEL						3	3	1	1	3	2
DEPTH				100	120	120	50	50	30	40	20
CLASS	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	MURL	BIFACE	BIFACE
RAW MATERIAL	CHERT	SRC	S.SILT.	SRC	CHAL.	CHAL.	S.SAND.	CHAL.	CHERT	SRC	OBS.
SOURCE											
POINT VARIETY		PRAIRIE		PLAINS	PRAIRIE	PLAINS					PLAINS
WEIGHT(gms)	1.5	0.4	0.9	0.9	0.6	0.6	1.7	1.0	0.6	0.5	0.2
MAXIMUM LENGTH	27.2	10.5	21.0	22.4	20.7	16.3	25.7	25.4	18.9	11.0	6.5
MAXIMUM WIDTH	15.4		14.7	14.0	13.2		14.7	13.9	10.3	10.8	
POS. MAX. WIDTH	10.7		9.2	6.3	6.4		8.5		7.9	3.7	
MAXIMUM THICKNESS	3.9		3.2	3.1	2.3	3.1	4.4	3.8	2.7	3.2	
POS. MAX. THICKNESS	13.0		3.9	9.4	6.8	11.4	14.3		4.1	6.8	
BLADE LENGTH	20.2		13.2	16.9	15.0	10.6		19.2	11.6		
STEM LENGTH	7.0	5.1	7.8	5.6	5.6	5.8	5.8		7.3	3.7	
BLADE WIDTH	15.4		14.7	14.0	13.2	11.2	14.7	13.9	10.3	9.3	
SHOULDER WIDTH	14.7		14.3	13.7	12.9			23.5	10.0	9.3	
POSITION SHOULDER	6.9		7.4	5.7	5.7		6.1		7.2	6.0	
NECK WIDTH	10.3		9.6	9.3	10.5		10.3		8.2	8.2	
POSITION NECK	5.4		5.3	4.7	4.5		4.9		5.6	5.0	
STEM WIDTH	14.1		12.3	13.9	12.6		13.1		9.8	10.8	13.8
BASE WIDTH	11.5		10.5	13.0	11.6		10.8		7.9	9.3	13.1
BASAL NOTCH DEPTH											
NOTCH 1 DEPTH	2.0		1.7	2.7	1.1		1.9			0.7	
NOTCH 1 BREADTH	3.6		3.7	2.5	2.4		3.1	3.3		2.5	
NOTCH 2 DEPTH	2.4	1.1	2.0	2.3	1.3	1.8	1.6		1.1	1.1	
NOTCH 2 BREADTH	4.1	2.8	3.9	1.3	2.4	2.9			3.2	3.0	
PROX.LAT.EDGE 1 HT.			2.5	2.3	2.4		2.1			3.2	3.1
PROX.LAT.EDGE 2 HT.		2.6	4.5	3.7	3.5	2.2	2.7			2.5	3.6
TIP ANGLE	85		90	75	80	75		65	60		
BLADE ANGLE											
EDGE 1 ANGLE	40		50	50	35	55	40	40	55	50	
EDGE 2 ANGLE	40		45	50	35	55	40	35	50	70	
INTEGRITY	1	9	1	1	1	5	2	5	1	2	4
LONG. CROSS SECTION	1	1	3	1	1	1	5	4	4	3	0
TRANS.CROSS SECTION	1	0	4	1	1	2	1	3	4	3	0
BLANK TYPE	0	0	0	0	0	0	0	0	2	0	0
BLANK ORIENTATION	0	0	6	0	0	0	0	0	4	0	0
FLAKING TYPE OB.	5	0	6	5	5	5	5	5	6	8	0
FLAKING PATTERN OB.	2	0	8	8	2	4	1	3	1	8	0
FLAKING TYPE RE.	5	0	5	5	5	5	5	5	6	8	0
FLAKING PATTERN RE.	4	0	1	8	4	1	1	1	1	8	0
BLADE EDGE 1 SHAPE	6	0	9	2	6	1	4	1	5	0	0
BLADE EDGE 1 MORPH.	2	0	2	2	2	1	2	1	6	0	0
BLADE EDGE 2 SHAPE	2	0	6	2	1	2	4	2	1	0	0
BLADE EDGE 2 MORPH.	2	0	2	2	1	5	2	2	6	0	0
SHOULDER 1 SHAPE	4	0	3	4	4	0	3	3	3	3	0
SHOULDER 2 SHAPE	6	4	3	1	4	3	0	0	3	4	0
EDGE GRINDING	1	0	1	9	9	0	0	0	0	9	0
BASE SHAPE	1	0	1	1	3	0	1	0	2	1	9
BASAL THINNING	3	0	3	3	3	3	3	0	2	0	2
NOTCH 1 SHAPE	7	0	4	2	4	0	4	4	0	6	0
NOTCH 1 ORIENTATION	1	0	1	1	1	0	1	1	0	1	0
NOTCH 2 SHAPE	4	4	4	2	4	4	4	0	4	4	0
NOTCH 2 ORIENTATION	1	1	1	1	1	1	1	0	1	1	0
NOTCHING TECHNIQUE	3	0	1	1	5	0	1	0	0	5	3
PROX. LATERAL EDGE 1	0	0	6	3	1	0	3	0	0	3	1
PROX. LATERAL EDGE 2	4	6	1	3	3	1	6	0	9	3	3
TIP MORPHOLOGY	1	7	2	2	1	1	5	2	1	7	0
WEAR TYPE	0	0	0	0	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0	0	0	0	0
HEAT TREATMENT	0	0	0	0	0	0	0	0	0	0	0
FIGURE REFERENCE	76n		78s	76q	77l		78u				

OLD WOMEN'S

CATALOGUE NUMBER	61568	61570	61647	61650	61651	61652	61927	61965	61966	62268	62376
UNIT	41	41	42	42	42	42	44	44	44	44	44
LEVEL	4	3	3	1	1	1	2	3	3	1	1
DEPTH	30	30	50	50	50	50	20	30	30	10	10
CLASS	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE
RAW MATERIAL	CHAL.	CHERT	S.WOOD	CHERT	CHERT	CHERT	CHERT	SRC	SRC	CHERT	S.WOOD
SOURCE				MAD.FM.		MAD.FM.				MAD.FM.	
POINT VARIETY	PRAIRIE				PLAINS		TOY		TOY	PLAINS	
WEIGHT(gms)	0.8	0.3	1.0	0.4	0.4	0.4	0.2	0.3	0.2	0.5	0.3
MAXIMUM LENGTH	16.8	16.2	22.6	14.7	9.4	12.9	11.4	7.3	10.4	8.3	8.7
MAXIMUM WIDTH	12.3	8.2	13.6	10.6					7.9		
POS. MAX. WIDTH	2.2	5.2	8.9	1.1					2.4		
MAXIMUM THICKNESS	3.9	1.9	3.8	2.5					2.3		
POS. MAX. THICKNESS	9.4	2.0	10.8	13.0					2.7		
BLADE LENGTH	10.9	12.1	15.6	8.9			7.2		4.9		
STEM LENGTH	6.0	4.2	7.0	5.8					5.5		
BLADE WIDTH	11.3	8.2	13.6	9.5			7.5		6.4		
SHOULDER WIDTH	11.3	7.7	13.2	9.2			7.5		6.4		
POSITION SHOULDER	6.0	3.7	7.6	5.2					5.4		
NECK WIDTH	9.5	5.4	8.7	8.4	10.5		5.9	8.4	5.9		
POSITION NECK	4.6	2.8	5.8	3.9	6.7				4.3		
STEM WIDTH	12.3	7.4	11.8	10.6					7.9	14.6	
BASE WIDTH	10.3	6.7	10.2	10.1	12.5				7.2	12.4	
BASAL NOTCH DEPTH											
NOTCH 1 DEPTH	1.1	1.0	1.8	1.3			1.4		0.8		
NOTCH 1 BREADTH	2.9	2.5	2.7	2.7			3.0		2.9		
NOTCH 2 DEPTH	1.3	1.3	2.3	0.9		1.6	1.0		1.0		
NOTCH 2 BREADTH	3.9	2.3	2.8	3.3		3.2	2.8		2.8		
PROX.LAT.EDGE 1 HT.	2.8	1.1	4.0	1.5					3.3	4.4	
PROX.LAT.EDGE 2 HT.	2.0	0.7	3.7	1.8	5.1			4.0	2.3	4.2	5.5
TIP ANGLE	70		80	60			70		70		
BLADE ANGLE		70									
EDGE 1 ANGLE	75	40	50	50			40		55		
EDGE 2 ANGLE	65	40	50	45		30	65		55		
INTEGRITY	1	1	1	1	4	8	5	4	1	4	4
LONG. CROSS SECTION	2	4	1	2	0	1	1	0	6	0	0
TRANS.CROSS SECTION	2	4	9	2	0	0	0	0	2	0	0
BLANK TYPE	0	2	0	3	0	0	0	0	0	0	0
BLANK ORIENTATION	0	0	0	0	0	0	0	0	0	0	0
FLAKING TYPE OB.	5	6	6	6	0	0	5	0	6	0	0
FLAKING PATTERN OB.	1	1	1	1	0	0	3	0	1	0	0
FLAKING TYPE RE.	5	6	6	6	0	0	6	0	6	0	0
FLAKING PATTERN RE.	1	1	1	1	0	0	4	0	1	0	0
BLADE EDGE 1 SHAPE	2	2	2	9	0	0	5	0	3	0	0
BLADE EDGE 1 MORPH.	2	5	5	2	0	0	1	0	4	0	0
BLADE EDGE 2 SHAPE	4	2	2	5	0	0	6	0	1	0	0
BLADE EDGE 2 MORPH.	2	5	2	1	0	0	1	0	1	0	0
SHOULDER 1 SHAPE	3	4	3	4	0	0	4	0	3	0	0
SHOULDER 2 SHAPE	3	4	3	4	0	3	3	0	3	0	0
EDGE GRINDING	9	2	9	9	0	0	0	0	0	1	0
BASE SHAPE	1	1	2	1	3	0	0	0	1	1	0
BASAL THINNING	3	2	2	3	3	0	3	0	2	3	0
NOTCH 1 SHAPE	4	4	4	6	0	0	6	0	6	0	0
NOTCH 1 ORIENTATION	1	1	1	1	0	0	1	1	1	0	0
NOTCH 2 SHAPE	4	4	4	6	2	4	4	0	6	0	0
NOTCH 2 ORIENTATION	1	1	1	1	1	1	1	1	1	0	0
NOTCHING TECHNIQUE	2	3	3	3	4	0	3	2	5	4	0
PROX. LATERAL EDGE 1	3	6	3	8	0	0	0	0	3	3	0
PROX. LATERAL EDGE 2	3	6	3	8	1	0	0	1	3	3	0
TIP MORPHOLOGY	1	2	1	2	0	7	1	0	1	0	0
WEAR TYPE	0	0	0	0	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0	0	0	0	0
HEAT TREATMENT	0	0	0	0	0	0	0	0	0	0	0
FIGURE REFERENCE	77e	78k	78t	79f					76e		

OLD WOMEN'S

CATALOGUE NUMBER	62378	62781	62953	62954	63043	63253	63254	63255	63367	63423	63726
UNIT	44	44	44	44	44	44	44	44	44	44	44
LEVEL	1	3	2	2	1	1	1	1	1	2	1
DEPTH	10	30	20	20	10	10	10	10	10	20	10
CLASS	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE
RAW MATERIAL	KRF	QTZITE	S.WOOD	PORC.	CHERT	OBS.	SRC	S.SILT.	S.WOOD	CHERT	S.MUD.
SOURCE											
POINT VARIETY			PRAIRIE	PEKISKO	TOY			TOY		PRAIRIE	PLAINS
WEIGHT(gms)	0.2	0.9	0.4	0.3	0.2	0.5	0.9	0.2	0.5	0.2	0.5
MAXIMUM LENGTH	5.8	19.0	15.1	9.6	7.3	13.1	17.2	11.6	12.6	6.7	13.9
MAXIMUM WIDTH		13.0					12.7				12.7
POS. MAX. WIDTH		2.5					3.4				1.7
MAXIMUM THICKNESS		3.3				4.2	3.7				3.0
POS. MAX. THICKNESS		6.8				6.2	10.8				8.5
BLADE LENGTH						6.8	9.0				
STEM LENGTH		6.5	6.5			6.3	8.2				6.2
BLADE WIDTH		12.6				11.2	11.8				12.2
SHOULDER WIDTH		12.4				11.1	11.8				12.1
POSITION SHOULDER		6.8				7.0	8.5				6.3
NECK WIDTH	9.1	10.0	7.0	7.2	4.5	8.8	8.3			9.3	9.0
POSITION NECK	5.0	4.6	3.5	5.6		5.4	6.0				5.3
STEM WIDTH	12.8			12.7	9.2		12.7		14.0		12.7
BASE WIDTH	11.9			11.0	8.4				13.9		12.0
BASAL NOTCH DEPTH		1.3									
NOTCH 1 DEPTH		1.4		2.9			1.3				1.5
NOTCH 1 BREADTH		3.6		3.1			4.2				2.1
NOTCH 2 DEPTH		1.9				1.6	2.8				1.9
NOTCH 2 BREADTH		3.6				2.6	3.3				2.5
PROX.LAT.EDGE 1 HT.	3.0			3.7					2.2	1.9	3.7
PROX.LAT.EDGE 2 HT.	3.8			4.2	4.2	3.0			2.6		3.3
TIP ANGLE											
BLADE ANGLE											
EDGE 1 ANGLE		45				50	50				40
EDGE 2 ANGLE		40				40	60				40
INTEGRITY	4	9	3	4	4	5	5	5	4	4	2
LONG. CROSS SECTION	0	1	0	1	0	1	1	0	0	0	1
TRANS.CROSS SECTION	0	1	0	0	0	1	2	0	0	0	1
BLANK TYPE	0	0	0	0	0	0	0	4	0	0	0
BLANK ORIENTATION	0	0	0	0	0	0	0	0	0	0	0
FLAKING TYPE OB.	0	8	0	0	0	5	5	6	0	0	5
FLAKING PATTERN OB.	0	8	0	0	0	3	4	1	0	0	3
FLAKING TYPE RE.	0	8	0	0	0	5	5	6	0	0	5
FLAKING PATTERN RE.	0	8	0	0	0	1	4	1	0	0	3
BLADE EDGE 1 SHAPE	0	6	0	0	0	1	2	1	0	0	0
BLADE EDGE 1 MORPH.	0	2	0	0	0	2	2	2	0	0	1
BLADE EDGE 2 SHAPE	0	0	0	0	0	5	1	1	0	0	0
BLADE EDGE 2 MORPH.	0	2	0	0	0	2	2	2	0	0	1
SHOULDER 1 SHAPE	0	4	0	6	0	3	3	0	0	0	3
SHOULDER 2 SHAPE	0	3	0	0	0	3	3	0	0	0	3
EDGE GRINDING	0	9	0	0	0	9	0	0	0	0	0
BASE SHAPE	3	3	1	3	3	1	0	0	1	0	3
BASAL THINNING	2	2	5	3	0	3	1	0	0	0	5
NOTCH 1 SHAPE	0	6	5	7	0	4	5	6	0	0	2
NOTCH 1 ORIENTATION	1	1	1	1	0	1	1	1	0	0	1
NOTCH 2 SHAPE	0	4	0	0	0	4	4	0	0	0	2
NOTCH 2 ORIENTATION	1	1	0	0	0	1	1	0	0	0	1
NOTCHING TECHNIQUE	3	1	0	1	3	5	6	0	4	3	5
PROX. LATERAL EDGE 1	3	7	0	3	0	0	0	0	1	1	1
PROX. LATERAL EDGE 2	3	7	0	3	1	1	0	0	1	0	1
TIP MORPHOLOGY	0	6	0	0	0	2	2	1	0	0	5
WEAR TYPE	0	0	0	0	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0	0	0	0	0
HEAT TREATMENT	0	0	7	0	0	0	0	0	0	0	0
FIGURE REFERENCE		76l		76b		77b					78p

OLD WOMEN'S

CATALOGUE NUMBER	63727	63825	63939	64168	64410	64555	64698	64805	64954	65066	65305
UNIT	44	44	44	44	45	45	45	45	45	45	45
LEVEL	1	1	1	1	1	2	1	1	3	2	1
DEPTH	10	10	10	10	10	20	10	10	30	20	10
CLASS	BIFACE	BIFACE	BIFACE	UNIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE
RAW MATERIAL	CHAL.	CHERT	S.WOOD	CHERT	S.MUD.	KRF	S.MUD.	QTZITE	SRC	CHERT	S.SILT.
SOURCE		TOW		MAD.FM.				FITS 64806			
POINT VARIETY	PLAINS	PLAINS		TOY						TOY	PLAINS
WEIGHT(gms)	0.2	0.6	0.5	0.2	0.7	0.4	0.6	0.6	0.5	0.1	1.1
MAXIMUM LENGTH	7.8	13.7	14.6	13.2	19.1	19.0	20.3	21.1	14.5	9.5	18.9
MAXIMUM WIDTH			11.9	9.2	10.4	11.8	10.4	10.8	10.5	7.7	16.2
POS. MAX. WIDTH			1.5		7.0	8.3	1.3	4.3	2.9	3.7	6.0
MAXIMUM THICKNESS		2.8	3.1	1.9	3.6	3.3	3.2	3.4	2.8	1.8	4.2
POS. MAX. THICKNESS			4.2		9.1	8.8	7.8	2.7	5.7	2.7	7.4
BLADE LENGTH			9.1	9.7		12.9	16.0	15.6	9.6		
STEM LENGTH			5.5		5.8	8.0	4.3	6.4	5.9	4.0	7.9
BLADE WIDTH			10.5	9.2	10.4	11.8	9.9	9.2	10.3	7.7	15.1
SHOULDER WIDTH			10.5	8.4	10.4	11.6	9.9	9.2	10.3	7.7	15.1
POSITION SHOULDER			6.4	3.4	7.0	7.0	4.1	6.3	7.2	4.1	8.9
NECK WIDTH			8.4	5.9	6.9			7.2	8.8	5.9	11.7
POSITION NECK			4..3	2.5	4.4	5.6	3.2	4.5	3.8	2.6	6.5
STEM WIDTH	13.4		11.9		9.3		9.4	10.8	10.5		16.2
BASE WIDTH	12.4		10.4		8.3		7.9	9.7	7.2		14.7
BASAL NOTCH DEPTH								1.0			1.0
NOTCH 1 DEPTH			1.4	1.3	1.6			1.1	1.0	1.0	2.2
NOTCH 1 BREADTH			3.8	2.3	2.6			3.0	3.6	4.5	3.7
NOTCH 2 DEPTH		2.0	1.6	0.7	1.7		1.0	1.3	0.7	0.6	1.8
NOTCH 2 BREADTH		3.0	2.6	2.0	3.8		2.5	3.1	3.5	2.5	2.4
PROX.LAT.EDGE 1 HT.					1.3			3.1	1.9	1.4	5.2
PROX.LAT.EDGE 2 HT.		4.3	2.0		3.4		1.7	3.3	2.3		6.5
TIP ANGLE			65	80		70	45	45			
BLADE ANGLE					30		35	40			60
EDGE 1 ANGLE		35	50	55	45	40	60	50	50	30	45
EDGE 2 ANGLE		35	10	50	40	40	35	55	50	30	50
INTEGRITY	4	9	1	5	2	5	1	1	1	9	2
LONG. CROSS SECTION	0	1	6	4	6	1	1	1	1	1	1
TRANS.CROSS SECTION	0	0	8	4	6	5	1	1	1	1	1
BLANK TYPE	0	0	0	2	4	0	0	0	0	0	0
BLANK ORIENTATION	0	0	0	0	0	0	0	0	0	0	0
FLAKING TYPE OB.	0	5	5	9	6	5	6	5	5	6	5
FLAKING PATTERN OB.	0	8	3	9	1	1	1	1	1	1	1
FLAKING TYPE RE.	0	5	5	6	5	5	6	5	5	1	5
FLAKING PATTERN RE.	0	8	1	2	1	4	1	1	1	2	1
BLADE EDGE 1 SHAPE	0	0	1	2	9	1	1	1	9	0	1
BLADE EDGE 1 MORPH.	0	0	2	6	7	1	1	1	1	1	1
BLADE EDGE 2 SHAPE	0	0	1	2	1	2	2	1	2	0	1
BLADE EDGE 2 MORPH.	0	0	2	8	7	1	1	1	1	1	1
SHOULDER 1 SHAPE	0	0	3	3	1	1	0	4	3	4	5
SHOULDER 2 SHAPE	0	4	3	3	4	9	2	3	3	0	6
EDGE GRINDING	0	0	0	0	9	9	9	9	9	9	2
BASE SHAPE	3	0	1	0	1	1	1	5	8	1	3
BASAL THINNING	0	0	2	0	2	3	2	3	1	3	3
NOTCH 1 SHAPE	0	0	5	8	3	3	9	3	4	4	3
NOTCH 1 ORIENTATION	0	0	2	2	1	1	9	1	1	1	1
NOTCH 2 SHAPE	0	4	4	5	4	9	3	3	3	3	3
NOTCH 2 ORIENTATION	0	1	1	1	1	9	1	1	1	1	1
NOTCHING TECHNIQUE	3	5	3	3	3	6	7	1	5	3	5
PROX. LATERAL EDGE 1	1	0	4	0	9	0	4	2	4	7	1
PROX. LATERAL EDGE 2	1	1	1	0	2	4	9	2	0	0	1
TIP MORPHOLOGY	0	5	2	1	4	1	1	1	6	7	6
WEAR TYPE	0	0	0	0	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0	0	0	0	0
HEAT TREATMENT	0	0	0	0	0	2	0	0	9	0	0
FIGURE REFERENCE		76x	77c	79h	77k	79m	79b	76p		78f	78r

OLD WOMEN'S

CATALOGUE NUMBER	65895	66292	67171	67173	67306	67596	67597	68026	68272	68329	68413
UNIT	45	45	46	46	46	46	46	46	46	46	46
LEVEL	2	2	1	1	1	1	1	2	2	1	2
DEPTH	20	20	10	10	10	10	10	20	20	10	20
CLASS	BIFACE	MURL	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE
RAW MATERIAL	OBS.	CHAL.	SRC	CHERT	CHAL.	CHAL.	OBS.	CHAL.	OBS.	S.WOOD	CHERT
SOURCE				MAD.FM.							
POINT VARIETY		TOY	PLAINS					PRAIRIE	TOY		TOY
WEIGHT(gms)	0.6	0.2	0.7	0.2	0.2	0.7	0.6	0.5	0.1	0.7	0.4
MAXIMUM LENGTH	19.7	13.1	15.9	5.5	6.2	18.3	15.9	15.1	8.2	22.9	13.7
MAXIMUM WIDTH	11.7	8.8						11.4	8.6	10.6	10
POS. MAX. WIDTH	6.6	1.5						7.1	2.5	13.4	1.8
MAXIMUM THICKNESS	3.1	2.1				4.1	3.4	3.4	2.3	3.2	3
POS. MAX. THICKNESS	8.8	5.1				9.5		1.9	6	9.8	6.3
BLADE LENGTH	13.8	7.6				12.2				14	9.1
STEM LENGTH	5.1	4.6						7.1	4.6	8.9	4.6
BLADE WIDTH	11.7	8.5				13.5	11	11.4		11.1	6.9
SHOULDER WIDTH	11.7	8.5	13.0			13.5	10.5	11.4		10	6.9
POSITION SHOULDER	6.6	4.7	7.5			6.9		7.1		9.7	4.6
NECK WIDTH	8.4	6.2	8.9			9.2		7.5	6.1	5.5	6.8
POSITION NECK	4.8	3.5	5.5			5.5		4.9	3.8	5.2	4.4
STEM WIDTH		8.9		11.8	10.9				8.6	8.6	10
BASE WIDTH				12.3	11.2				8.6	8.6	9.1
BASAL NOTCH DEPTH											
NOTCH 1 DEPTH		0.6						1.6		2.5	0.8
NOTCH 1 BREADTH		2.8						4.6		6.2	3.7
NOTCH 2 DEPTH	1.5	1.6	1.8						1.3	1.3	0.7
NOTCH 2 BREADTH	2.7	4.0	2.4						3.4	6.6	4.6
PROX.LAT.EDGE 1 HT.		2.9		4.8	3.2			1.2	1.9	0.9	2.2
PROX.LAT.EDGE 2 HT.	2.8		5.6	3.9	3.5				2.4	2	1.9
TIP ANGLE	65	75				75				75	60
BLADE ANGLE						75		40		45	40
EDGE 1 ANGLE	40	40				45	40	35		50	50
EDGE 2 ANGLE	50	40				50	40	40		40	65
INTEGRITY	5	5	9	4	4	5	3	9	3	1	1
LONG. CROSS SECTION	1	3	0	0	0	1	0	8	1	3	3
TRANS.CROSS SECTION	1	1	3	1	1	5	1	5	1	1	3
BLANK TYPE	0	2	0	0	0	0	0	0	0	0	4
BLANK ORIENTATION	0	6	0	0	0	0	0	0	0	0	0
FLAKING TYPE OB.	5	6	8	0	0	5	5	5	5	5	6
FLAKING PATTERN OB.	1	1	8	0	0	1	3	1	1	1	1
FLAKING TYPE RE.	5	6	8	0	0	5	5	6	5	6	6
FLAKING PATTERN RE.	1	1	8	0	0	1	3	1	1	1	1
BLADE EDGE 1 SHAPE	2	2	0	0	0	1	0	1	0	2	9
BLADE EDGE 1 MORPH.	1	4	0	0	0	1	1	1	0	4	5
BLADE EDGE 2 SHAPE	2	5	0	0	0	1	0	9	0	2	9
BLADE EDGE 2 MORPH.	1	1	0	0	0	1	1	1	0	4	6
SHOULDER 1 SHAPE	1	1	1	0	0	2	1	4	0	3	4
SHOULDER 2 SHAPE	8	3	2	0	0	5	1	4	3	4	4
EDGE GRINDING	9	9	0	9	9	0	0	2	2	9	9
BASE SHAPE	1	1	1	1	1	0	0	1	1	2	8
BASAL THINNING	3	1	0	3	2	0	0	2	2	3	2
NOTCH 1 SHAPE	0	1	0	0	0	7	0	7	0	4	6
NOTCH 1 ORIENTATION	0	1	0	0	0	1	0	3	0	1	1
NOTCH 2 SHAPE	3	4	2	0	0	0	0	0	7	6	6
NOTCH 2 ORIENTATION	1	1	1	0	0	0	0	0	2	1	1
NOTCHING TECHNIQUE	3	3	2	0	0	0	0	2	4	4	1
PROX. LATERAL EDGE 1	0	3	0	1	1	0	0	7	6	5	9
PROX. LATERAL EDGE 2	1	0	1	1	1	0	0	0	1	1	9
TIP MORPHOLOGY	1	1	0	0	0	1	5	5	4	2	1
WEAR TYPE	0	0	0	0	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0	0	0	0	0
HEAT TREATMENT	0	9	9	0	0	0	0	9	0	0	9
FIGURE REFERENCE		78d						76k	78g	79a	78m

OLD WOMEN'S

CATALOGUE NUMBER	68488	68619	69070	69557	6[illegible]654	69882	69883	69884	69922	70005	70006
UNIT	46	47	47	47	47	47	47	47	47	47	47
LEVEL	2	1	1	1	2	1	1	1	2	1	1
DEPTH	20	10	10	10	20	10	10	10	20	10	10
CLASS	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	MURL	BIFACE
RAW MATERIAL	CHAL.	S.SILT.	SRC	CHERT	CHERT	SRC	SRC	CHERT	S.MUD.	S.WOOD	CHAL.
SOURCE				TOW							
POINT VARIETY			PLAINS			PLAINS		PRAIRIE		TOY	WASHITA
WEIGHT(gms)	0.2	0.3	0.8	0.5	0.5	1.0	0.5	0.6	0.5	0.2	0.5
MAXIMUM LENGTH	8	8.2	13.3	10.0	15.9	18.7	15.8	18.1	14.7	11.7	14.0
MAXIMUM WIDTH			15.2		10.9			10.6		8.5	13.4
POS. MAX. WIDTH			1.3		1.8			1.9		5.3	
MAXIMUM THICKNESS			4.9		3.5	4.2	3.5	2.9	3.2	1.7	3.3
POS. MAX. THICKNESS			7.0		6.1			8.8		5.7	
BLADE LENGTH			3.0		8.6				8.2	6.4	
STEM LENGTH			10.3		7.3			9.0		5.3	
BLADE WIDTH			11.2		7.6	13.7		9.5	9.4	8.4	11.4
SHOULDER WIDTH			11.2		7.0	13.7		9.5	9.4	8.4	11.4
POSITION SHOULDER			9.1		6.3			9.0		5.3	
NECK WIDTH		8.0	9.4	9.1	5.8			6.7	7.8	7.1	8.2
POSITION NECK			6.3	5.3	5.6			6.5		3.9	
STEM WIDTH			13.8	12.5	10.9			10.5		8.2	13.1
BASE WIDTH			14.9	10.0	10.5			9.4		7.5	
BASAL NOTCH DEPTH					0.7						
NOTCH 1 DEPTH			1.7		1.4	1.5		1.1	1.9	0.8	2.3
NOTCH 1 BREADTH			4.2		3.1	3.5		3.9	3.4	3.1	3.4
NOTCH 2 DEPTH		2.0	1.4		1.7		1.1	2.2	1.5	1.0	2.0
NOTCH 2 BREADTH		3.4	5.0		2.6		4.6	5.1	4.8	2.0	2.4
PROX.LAT.EDGE 1 HT.			5.2	3.8	5.5	4.7		4.5	3.4	1.9	4.7
PROX.LAT.EDGE 2 HT.			4.5	4.2	5.0			3.3		2.4	
TIP ANGLE			115		125		75		80	80	
BLADE ANGLE					40	40	50	50	55	60	
EDGE 1 ANGLE			60		65	30	50	45	60	55	40
EDGE 2 ANGLE			75		60	45	65	45	55	45	40
INTEGRITY	4	4	1	4	1	9	5	2	5	1	9
LONG. CROSS SECTION	0	0	1	0	1	1	3	2	8	2	1
TRANS.CROSS SECTION	2	0	1	1	1	1	8	2	1	2	1
BLANK TYPE	0	0	0	0	0	0	0	0	0	0	0
BLANK ORIENTATION	0	0	0	0	0	0	0	0	0	0	0
FLAKING TYPE OB.	0	0	5	1	5	5	8	6	0	6	8
FLAKING PATTERN OB.	0	0	1	1	1	1	8	1	0	1	8
FLAKING TYPE RE.	0	0	5	5	5	5	8	5	0	6	5
FLAKING PATTERN RE.	0	0	1	1	1	1	8	3	0	1	1
BLADE EDGE 1 SHAPE	0	0	1	0	9	1	1	1	1	9	9
BLADE EDGE 1 MORPH.	0	0	1	0	1	5	1	9	9	9	1
BLADE EDGE 2 SHAPE	0	0	1	0	9	1	9	1	9	9	1
BLADE EDGE 2 MORPH.	0	0	1	0	9	5	4	9	9	9	1
SHOULDER 1 SHAPE	0	0	3	3	4	1	0	3	6	3	5
SHOULDER 2 SHAPE	0	0	4	0	8	0	8	4	8	3	1
EDGE GRINDING	1	0	1	0	9	9	0	9	9	9	9
BASE SHAPE	8	0	1	1	8	0	0	8	3	2	3
BASAL THINNING	2	0	3	2	3	2	0	3	3	2	3
NOTCH 1 SHAPE	0	0	4	7	2	3	0	4	3	6	2
NOTCH 1 ORIENTATION	0	0	1	3	1	1	0	1	1	1	1
NOTCH 2 SHAPE	4	7	4	0	2	0	6	3	6	3	2
NOTCH 2 ORIENTATION	1	1	1	0	1	0	1	1	1	1	1
NOTCHING TECHNIQUE	0	3	3	3	1	0	0	5	2	4	1
PROX. LATERAL EDGE 1	0	0	8	8	9	8	0	6	3	4	1
PROX. LATERAL EDGE 2	4	0	2	6	1	0	7	9	0	9	0
TIP MORPHOLOGY	0	0	8	0	2	6	1	5	1	5	5
WEAR TYPE	0	0	9	0	0	0	0	2	0	0	0
WEAR LOCATION	0	0	9	0	0	0	0	2	0	0	0
HEAT TREATMENT	9	0	9	9	3	9	9	9	0	0	0
FIGURE REFERENCE			76d		78j			78l	77p	78e	76h

OLD WOMEN'S

CATALOGUE NUMBER	70007	70111	70218	70338	70339	70943	71470	71471	71593	71594	71702
UNIT	47	47	47	47	47	47	47	47	999	999	44
LEVEL	1	1	1	1	1	2	2	2			1
DEPTH	10	10	10	10	10	20	20	20			
CLASS	BIFACE	MURL	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE
RAW MATERIAL	CHERT	OBS.	CHERT	CHERT	OBS.	CHAL.	CHERT	KRF	PORC.	SRC	S.WOOD
SOURCE			MAD.FM.	MAD.FM.			ETHER.				
POINT VARIETY			PLAINS	PLAINS			PRAIRIE	WASHITA	TOY	TOY	
WEIGHT(gms)	0.7	0.3	0.1	0.2	0.1	0.6	0.6	0.6	0.1	0.3	0.8
MAXIMUM LENGTH	15.7	13.3	6.6	8.4	4.6	18.2	16.7	16.3	10.1	12.6	16.7
MAXIMUM WIDTH	12.3	10.6				12.3	12.7	14.2	7.0		12.5
POS. MAX. WIDTH	6.3	1.6				5.7	3.1		1.7		
MAXIMUM THICKNESS	4.2	2.2				3.1	3.5	2.6	2.1	2.6	3.6
POS. MAX. THICKNESS	6.1	1.2				11.9	9.2	2.6	10.1	6.9	
BLADE LENGTH		7.5				13.0	9.6			6.2	
STEM LENGTH	6.3	5.8				5.2	7.1	7.9	3.4	5.9	
BLADE WIDTH	12.3	8.2				12.3	12.4	12.1	6.7	9.6	12.5
SHOULDER WIDTH	12.3	8.2				12.3	12.4	12.1	6.7	9.6	12.5
POSITION SHOULDER	6.3	5.8				5.7	7.1	7.9	4.2	5.9	
NECK WIDTH	6.1	7.2				7.0	9.4	8.2	5.2	6.6	9.4
POSITION NECK	4.5	4.2				3.8	4.8	6.6	3.0	4.1	
STEM WIDTH		10.5					12.5	13.4	7.0		
BASE WIDTH		6.7					8.5	13.2	4.9		
BASAL NOTCH DEPTH					1.6			0.6			
NOTCH 1 DEPTH		1.2					1.4	2.3	0.9		1.4
NOTCH 1 BREADTH		3.1					3.3	2.5	2.7		3.8
NOTCH 2 DEPTH	2.4	1.1					0.9	2.5	1.0		
NOTCH 2 BREADTH	3.5	3.0					3.7	2.4	2.5		
PROX.LAT.EDGE 1 HT.		3.2			4.4		3.4	5.6	2.6		
PROX.LAT.EDGE 2 HT.	3.7	1.6	4.8	4.3			2.9	7.7	3.5		
TIP ANGLE		85				105	80			110	
BLADE ANGLE		55				45	50		40	65	40
EDGE 1 ANGLE	40	55				50	45	40	35	50	50
EDGE 2 ANGLE	40	35				40	50	35	40	60	45
INTEGRITY	9	1	4	4	4	5	1	2	2	5	9
LONG. CROSS SECTION	1	2	0	0	0	3	9	2	9	3	1
TRANS.CROSS SECTION	1	4	0	0	0	3	7	2	1	3	1
BLANK TYPE	0	1	0	0	0	0	1	0	0	0	0
BLANK ORIENTATION	0	6	0	0	0	0	2	0	0	0	0
FLAKING TYPE OB.	5	6	0	0	0	6	5	5	6	8	5
FLAKING PATTERN OB.	1	1	0	0	0	1	1	1	1	8	1
FLAKING TYPE RE.	5	6	0	0	0	5	6	5	5	8	5
FLAKING PATTERN RE.	1	1	0	0	0	1	1	1	1	8	1
BLADE EDGE 1 SHAPE	0	1	0	0	0	2	2	1	2	1	1
BLADE EDGE 1 MORPH.	0	1	0	0	0	4	1	1	1	4	1
BLADE EDGE 2 SHAPE	0	9	0	0	0	2	2	0	1	1	1
BLADE EDGE 2 MORPH.	0	1	0	0	0	4	1	0	1	1	1
SHOULDER 1 SHAPE	1	3	0	0	0	1	4	3	4	6	3
SHOULDER 2 SHAPE	1	4	0	0	0	1	4	1	5	5	4
EDGE GRINDING	1	1	0	0	0	9	2	9	9	0	0
BASE SHAPE	1	8	0	1	3	1	1	3	1	1	0
BASAL THINNING	6	2	0	0	0	3	3	5	3	0	0
NOTCH 1 SHAPE	0	4	0	0	0	3	4	2	3	0	4
NOTCH 1 ORIENTATION	1	1	0	0	0	1	1	1	1	0	1
NOTCH 2 SHAPE	7	4	0	0	0	0	6	2	3	0	0
NOTCH 2 ORIENTATION	1	1	0	0	0	1	1	1	1	0	0
NOTCHING TECHNIQUE	5	1	0	0	0	3	4	4	3	0	1
PROX. LATERAL EDGE 1	0	3	0	0	1	0	3	1	3	0	0
PROX. LATERAL EDGE 2	1	7	9	1	0	0	3	1	3	0	0
TIP MORPHOLOGY	4	1	0	6	0	1	1	5	5	1	4
WEAR TYPE	0	0	0	0	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0	0	0	0	0
HEAT TREATMENT	7	0	0	0	0	2	9	3	0	0	1
FIGURE REFERENCE	77f	78l				79c		79n	76g	78c	77d

OLD WOMEN'S

CATALOGUE NUMBER	71704	72016	72096	72133	72182	73073	73685	73800	73804	73873	73874
UNIT	44	43	43	43	4	4	49	49	49	49	49
LEVEL	1	2	3	1	2	2	1	1	1	1	1
DEPTH		35	45	43	20	20	10	10	10	10	10
CLASS	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE
RAW MATERIAL	CHERT	CHERT	SRC	QTZITE	S. WOOD	OBS.	CHERT	SRC	SRC	SRC	CHERT
SOURCE	MAD.FM.						TOW				
POINT VARIETY		PRAIRIE						PLAINS		PLAINS	PRAIRIE
WEIGHT(gms)	0.2	0.3	0.3	0.4	0.6	0.2	0.5	1.0	0.3	0.5	0.5
MAXIMUM LENGTH	8.8	13.9	14.6	15.2	14.5	7.7	12.4	19.7	6	13.0	10.8
MAXIMUM WIDTH		9.2		9.4			10.8				
POS. MAX. WIDTH		5.3					2.9				
MAXIMUM THICKNESS		2.3	2.6	2.7	4.1		3.3	4.1			
POS. MAX. THICKNESS		4.1					3.9	10.7			
BLADE LENGTH		8.8	9.9	10.4			5.4				
STEM LENGTH						2.8	7.0	7.4		7.5	
BLADE WIDTH			9.5	9.4			10.0	13.1			
SHOULDER WIDTH		9.2	9.2	9.4		8.8	10.0	13.1		12.6	
POSITION SHOULDER		5.3				2.8	7.0	7.4		7.5	
NECK WIDTH		6.2	6.8	6.5		6.8	8.0	9.5		9.3	9.4
POSITION NECK		3.4				2.2	5.3	6.3		5.7	5.6
STEM WIDTH						8	10.8			13.3	13.2
BASE WIDTH						7.3	5.7		11.9	11.8	5.5
BASAL NOTCH DEPTH											
NOTCH 1 DEPTH		1.3		1.5	1.9	1.1	1.6	2.9		1.8	
NOTCH 1 BREADTH		2.9		3.6	3.2	1.8	3.6	3.1		4.5	
NOTCH 2 DEPTH	0.9	1.4	0.9	0.5		0.9	1.3			2.5	
NOTCH 2 BREADTH	3.4	2.7	3	4.2		2.3	3.2			2.6	
PROX.LAT.EDGE 1 HT.		2.8		2.2	3.1		2.9	4.0		2.7	
PROX.LAT.EDGE 2 HT.	2.3		1.7			1.1				3.6	
TIP ANGLE		85	60	80			75				
BLADE ANGLE		50	65	45			75	40			
EDGE 1 ANGLE		30	35	55	45		70	50			
EDGE 2 ANGLE		30	35	65	55		70	50			
INTEGRITY	4	5	5	5	3	3	1	9	4	3	2
LONG. CROSS SECTION	0	2	0	3	0	0	1	1	0	0	0
TRANS.CROSS SECTION	0	2	1	3	9	2	1	1	0	2	1
BLANK TYPE	0	0	0	0	0	0	0	0	0	0	0
BLANK ORIENTATION	0	0	0	0	0	0	0	0	0	0	0
FLAKING TYPE OB.	0	5	8	8	5	0	5	5	0	5	0
FLAKING PATTERN OB.	0	1	8	8	1	0	1	1	0	1	0
FLAKING TYPE RE.	0	5	8	8	5	0	5	5	0	5	0
FLAKING PATTERN RE.	0	1	8	8	1	0	1	1	0	1	0
BLADE EDGE 1 SHAPE	0	2	5	2	0	0	2	2	0	0	0
BLADE EDGE 1 MORPH.	0	1	1	1	0	0	1	1	0	0	0
BLADE EDGE 2 SHAPE	0	2	2	2	0	0	1	1	0	0	0
BLADE EDGE 2 MORPH.	0	1	1	1	0	0	1	1	0	0	0
SHOULDER 1 SHAPE	0	3	3	1	2	1	3	1	0	0	0
SHOULDER 2 SHAPE	4	3	3	4	0	1	2	1	0	1	0
EDGE GRINDING	0	0	0	0	0	3	2	9	0	1	2
BASE SHAPE	0	0	0	0	0	8	1	1	1	1	2
BASAL THINNING	0	0	0	0	0	3	3	7	0	3	3
NOTCH 1 SHAPE	0	7	0	8	7	4	4	2	0	4	0
NOTCH 1 ORIENTATION	0	1	0	3	1	3	1	1	0	1	0
NOTCH 2 SHAPE	6	4	4	6	0	4	7	1	0	2	0
NOTCH 2 ORIENTATION	1	1	3	3	0	3	1	1	0	1	0
NOTCHING TECHNIQUE	0	1	0	3	0	3	3	3	0	5	0
PROX. LATERAL EDGE 1	0	8	0	8	6	5	3	3	0	1	0
PROX. LATERAL EDGE 2	5	0	7	0	0	4	6	0	8	1	9
TIP MORPHOLOGY	0	1	1	1	9	0	2	6	0	0	6
WEAR TYPE	0	0	0	0	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0	0	0	0	0
HEAT TREATMENT	0	3	0	0	3	0	0	0	0	0	0
FIGURE REFERENCE		79i		79j			79g	76o		76i	

OLD WOMEN'S

CATALOGUE NUMBER	73916	73919	73996	73998	74067	74166	74623	74654	75152	75156	75282
UNIT	49	49	49	49	49	49	49	49	49	49	49
LEVEL	1	1	1	1	1	1	2	2	2	2	2
DEPTH	10	10	10	10	10	10	20	20	20	20	20
CLASS	BIFACE	MURL	UNIFACE	BIFACE	BIFACE	BIFACE	BIFACE	MURL	MURL	MURL	BIFACE
RAW MATERIAL	CHERT	QTZITE	CHERT	S.SILT	OBS.	CHERT	S.MUD.	CHERT	CHERT	S.MUD.	SRC
SOURCE			TOW								
POINT VARIETY	PRAIRIE		TOY	PLAINS	PLAINS		PRAIRIE	PRAIRIE	PRAIRIE	PRAIRIE	
WEIGHT(gms)	0.7	0.3	0.2	0.2	0.3	1.1	0.4	1.0	0.3	0.3	0.2
MAXIMUM LENGTH	16.4	17.6	13.4	5.8	6.1	21.1	20.1	11.7	12.6	10.2	9.5
MAXIMUM WIDTH	12.8		8.3				12.0	10.1	9.9		11
POS. MAX. WIDTH	4.2		4.9				8.3	5.5	7.2		2.9
MAXIMUM THICKNESS	3.1		1.8				2.9		1.8		2.9
POS. MAX. THICKNESS	10.3		6.1				7.7		1.4		5.1
BLADE LENGTH		11.8	8.8			17					3
STEM LENGTH	8.2		4.9				8.1	5.2	6.0	7.4	5.7
BLADE WIDTH	11.6	10.3	8.3			14	12.0	10.1	9.9		8.5
SHOULDER WIDTH	11.7	10.3	8.3			14	12.0	10.1	9.9	11.3	8.5
POSITION SHOULDER	4.2		4.9				8.1	5.2	6.0	7.4	5.7
NECK WIDTH	8.2		6.2		8.2		9.4	7.1	7.0	8.3	8.1
POSITION NECK	6.4		2.9		4.5		5.8	3.8	4.9	5.8	4.5
STEM WIDTH	13.0		7.6				10.9	8.9	8.3	9.7	11
BASE WIDTH	9.9		6.1				8.1		7.9	9.4	8.5
BASAL NOTCH DEPTH										0.3	
NOTCH 1 DEPTH	1.9		1.1				0.9	1.6	1.2	1.5	1.1
NOTCH 1 BREADTH	3.6		2.8				5.0	2.0	2.4	3.5	1.9
NOTCH 2 DEPTH	1.8	1.0	1.1				1.1	0.9	1.3	1.0	0.7
NOTCH 2 BREADTH	4.2	2.9	2.5				4.0	3.3	2.8	2.3	1.3
PROX.LAT.EDGE 1 HT.	5.1			3.9	4.5		2.9	2.4			3.2
PROX.LAT.EDGE 2 HT.	4.5						3.5				3.6
TIP ANGLE		65	70			55	65				95
BLADE ANGLE	50	35	35			35	20				95
EDGE 1 ANGLE	40	40	65			55	55	50			60
EDGE 2 ANGLE	60	50	55			60	40		40		60
INTEGRITY	2	5	1	4	4	5	2	2	2	3	1
LONG. CROSS SECTION	2	9	9	0	0	1	1	0	9	0	5
TRANS.CROSS SECTION	1	9	9	0	0	1	1	1	1	1	1
BLANK TYPE	0	0	2	0	0	0	0	0	2	0	0
BLANK ORIENTATION	0	0	2	0	0	0	0	0	1	0	0
FLAKING TYPE OB.	1	8	5	0	0	5	5	5	5	5	5
FLAKING PATTERN OB.	4	8	1	0	0	1	1	1	1	1	1
FLAKING TYPE RE.	6	8	5	0	0	5	7	5	5	5	5
FLAKING PATTERN RE.	1	8	1	0	0	1	4	1	1	1	1
BLADE EDGE 1 SHAPE	1	1	2	0	0	2	2	0	0	0	1
BLADE EDGE 1 MORPH.	1	4	4	0	0	1	9	4	0	0	1
BLADE EDGE 2 SHAPE	1	1	1	0	0	2	2	0	2	0	1
BLADE EDGE 2 MORPH.	1	1	4	0	0	1	2	4	0	0	1
SHOULDER 1 SHAPE	1	3	3	0	0	3	3	1	3	1	3
SHOULDER 2 SHAPE	2	3	1	0	0	4	3	3	3	4	3
EDGE GRINDING	9	0	9	0	1	0	9	9	9	9	9
BASE SHAPE	1	0	1	1	1	0	8	1	2	3	1
BASAL THINNING	3	0	1	3	3	0	6	3	2	3	5
NOTCH 1 SHAPE	3	0	5	0	0	5	6	7	6	4	7
NOTCH 1 ORIENTATION	1	0	1	0	0	1	1	1	1	1	2
NOTCH 2 SHAPE	3	4	4	0	0	0	4	6	4	6	7
NOTCH 2 ORIENTATION	1	1	1	0	0	0	1	1	1	1	2
NOTCHING TECHNIQUE	3	0	4	0	0	0	5	2	5	3	1
PROX. LATERAL EDGE 1	1	0	4	1	3	0	3	3	6	6	3
PROX. LATERAL EDGE 2	3	0	4	0	0	0	3	0	4	6	3
TIP MORPHOLOGY	6	1	1	0	0	1	5	0	0	0	1
WEAR TYPE	0	0	0	0	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0	0	0	0	0
HEAT TREATMENT	0	0	0	0	0	0	0	0	0	0	0
FIGURE REFERENCE	78q		76f						78a		76c

OLD WOMEN'S

CATALOGUE NUMBER	75283	75285	76048	76050	76179	76687	76718	76853	77067	77176	77324
UNIT	49	49	50	50	50	50	50	50	50	50	50
LEVEL	2	2	1	1	1	2	2	2	2	2	2
DEPTH	20	20	16	13	16	22	20	31	20	28	24
CLASS	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	MURL	BIFACE	BIFACE
RAW MATERIAL	QTZITE	PORC.	KRF	OBS.	SRC	CHAL.	S.WOOD	CHERT	CHERT	CHERT	S.PEAT
SOURCE											
POINT VARIETY		PLAINS	PLAINS		PRAIRIE	TOY	PRAIRIE	PRAIRIE		PLAINS	
WEIGHT(gms)	0.4	0.5	0.9	0.6	0.4	0.4	0.3	0.6	0.6	0.3	1.1
MAXIMUM LENGTH	16.5	15.1	24.2	18.1	15.7	13.7	10.0	20.9	13.7	6.2	22.3
MAXIMUM WIDTH	11.2	12.6	15.2	12.5	10.0	8.6		11.5			13.3
POS. MAX. WIDTH		2.3	9.0	1.9	6.1	6.4		5.8			11.7
MAXIMUM THICKNESS	2.6	2.7	2.9	3.5	2.8	2.0		2.4			3.3
POS. MAX. THICKNESS	9.9	5.6	10.9	11.9	6.9	2.8		13.9			11.3
BLADE LENGTH	9		18.3	10.9	10.7	8.0		15.8			
STEM LENGTH		6.7	6.4	7	5.0	5.7	6.3	5.1			6.9
BLADE WIDTH	11.2	11.1	15.2	8.5	10.1	8.5		11.5			13.3
SHOULDER WIDTH	11.2	11.1	14.8	8.5	10.0	8.5	9.7	11.5			12.5
POSITION SHOULDER		6.7	6.5	7.3	5.3	5.7	6.3	5.1			6.9
NECK WIDTH	8.2	7.9	8.0	8.3	6.8	5.4	7.1	7.8			7.4
POSITION NECK		5.0	5.6	6	3.9	3.8	4.8	3.9			5.7
STEM WIDTH		12.5	14.4	11.3	8.3	7.3	9.5	10.2			12.6
BASE WIDTH		12.1	9.9	7.5	5.4	4.7	8.9	8.0			10.9
BASAL NOTCH DEPTH			1.1		0.7						1.2
NOTCH 1 DEPTH	1.3	2.1	3.8	1.4	1.3	1.4	1.9	1.6			2.5
NOTCH 1 BREADTH	4.1	3.8	2.7	3.4	3.2	3.2	3.3	3.3			4.9
NOTCH 2 DEPTH		2.0	3.4	1.5	0.8	1.3	2.0	1.8			2.7
NOTCH 2 BREADTH		2.9	2.8	3.2	3.1	3.4	3.4	3.9			5.2
PROX.LAT.EDGE 1 HT.		2.8	2.4	2.8	3.4		3.0	2.4		3.3	2.6
PROX.LAT.EDGE 2 HT.		3.1	4.7	3.8	3.9		3.9	1.4		4.7	3.1
TIP ANGLE	70		80	60	110	70		70			
BLADE ANGLE	50	55	40		50	65		35			
EDGE 1 ANGLE	55	55	35	65	45	55		50			25
EDGE 2 ANGLE	60	65	35	65	50	55		50			40
INTEGRITY	5	2	1	1	1	1	4	1	4	4	2
LONG. CROSS SECTION	1	1	1	1	9	2	0	1	0	0	3
TRANS.CROSS SECTION	1	1	1	1	1	2	1	1	0	0	3
BLANK TYPE	0	4	0	0	0	2	0	0	1	0	0
BLANK ORIENTATION	0	0	0	0	0	2	0	0	1	0	0
FLAKING TYPE OB.	8	5	5	5	8	6	0	5	5	0	6
FLAKING PATTERN OB.	8	1	1	1	8	1	0	1	1	0	1
FLAKING TYPE RE.	8	5	5	5	8	6	0	5	5	0	5
FLAKING PATTERN RE.	8	1	1	1	8	1	0	1	1	0	1
BLADE EDGE 1 SHAPE	2	4	2	5	9	2	0	2	0	0	1
BLADE EDGE 1 MORPH.	1	9	1	1	1	1	0	1	0	0	1
BLADE EDGE 2 SHAPE	3	2	2	9	3	2	0	2	0	0	1
BLADE EDGE 2 MORPH.	1	1	1	9	6	4	0	1	0	0	1
SHOULDER 1 SHAPE	4	1	1	4	1	3	0	3	0	0	1
SHOULDER 2 SHAPE	1	4	1	0	4	1	2	3	0	0	4
EDGE GRINDING	0	2	9	1	9	9	1	9	0	0	2
BASE SHAPE	4	1	3	2	3	1	1	1	1	1	3
BASAL THINNING	0	6	3	3	0	1	3	3	3	3	2
NOTCH 1 SHAPE	4	7	2	4	4	4	4	4	0	0	4
NOTCH 1 ORIENTATION	1	1	1	1	1	1	1	2	0	0	3
NOTCH 2 SHAPE	0	7	2	6	3	4	1	4	5	0	4
NOTCH 2 ORIENTATION	0	1	1	1	1	1	1	2	1	0	3
NOTCHING TECHNIQUE	0	5	4	3	4	5	3	3	0	0	3
PROX. LATERAL EDGE 1	7	2	7	5	3	8	7	3	0	2	3
PROX. LATERAL EDGE 2	0	1	3	2	6	8	1	7	0	1	2
TIP MORPHOLOGY	1	6	1	1	2	1	0	1	0	0	6
WEAR TYPE	0	0	0	0	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0	0	0	0	0
HEAT TREATMENT	0	0	3	0	0	3	0	0	0	0	0
FIGURE REFERENCE		76a	79o	77j		78b		76m			76j

	OLD WOMEN'S				AVONLEA					
CATALOGUE NUMBER	77405	77406	77451	77916	61004	61034	61036	61037	61038	63516
UNIT	50	50	50	50	39	40	40	40	40	44
LEVEL	2	2	3	3		1	1	1	1	2
DEPTH	20	20	31	30		50	50	50	50	20
CLASS	MURL	BIFACE	MURL	MURL	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE
RAW MATERIAL	CHERT	S.WOOD	S.MUD.	CHERT	SRC	CHERT	S.MUD.	SRC	SRC	SRC
SOURCE						MAD.FM.				
POINT VARIETY										
WEIGHT(gms)	0.4	0.5	0.6	0.3	0.5	0.6	0.5	0.2	0.4	0.3
MAXIMUM LENGTH	12.3	15.4	17.6	14.1	15.6	18.2	18.2	14.5	11.6	10.8
MAXIMUM WIDTH			13.4	10.9	12.8	12.4				
POS. MAX. WIDTH				3.5	4.5	5.8			6.2	
MAXIMUM THICKNESS				2.3	2.8	2.4	2.2		2.8	
POS. MAX. THICKNESS				6.9	6.1	7.5	6.0		5.5	
BLADE LENGTH			11.4	10.6	11.1					
STEM LENGTH	7.6	6.3		3.5	4.2	5.5	5.3		4.7	
BLADE WIDTH	11.8	11.9	12.7	10.0	12.8	12.4	10.9			
SHOULDER WIDTH	11.8	11.9	12.7	10.0	12.7	11.8	10.8			
POSITION SHOULDER	7.6	6.3		3.5	4.4	5.5	6.0			
NECK WIDTH	9.6	9.7	11.1	9.0	10.7	8.6	8.8		9.0	
POSITION NECK	4.8	5.0		5.0	3.1	4.1	3.9		3.6	
STEM WIDTH	11.9	12.9	13.4	10.9	12.0	11.7				
BASE WIDTH	9.8	10.5		8.6	11.4	11.2				
BASAL NOTCH DEPTH		0.9								
NOTCH 1 DEPTH	2.0	1.7	1.1	0.7	0.8	1.7		1.5		
NOTCH 1 BREADTH	3.8	3.8	2.6	2.2	2.7	2.8		3.8		
NOTCH 2 DEPTH	1.2	1.5	1.1	0.9	1.0	1.5	1.2		0.7	1.0
NOTCH 2 BREADTH	3.1	2.8	3.3	3.9	1.9	3.6	3.0		1.7	2.2
PROX.LAT.EDGE 1 HT.	1.3	1.9		2.5	1.1	2.1	1.2	2.5		
PROX.LAT.EDGE 2 HT.	2.2	3.0		2.5	1.5	1.9	1.8		1.7	2.5
TIP ANGLE			75	80	70					
BLADE ANGLE			35	70						
EDGE 1 ANGLE			60		45	30	35			
EDGE 2 ANGLE		55	60	55	45	35	30			
INTEGRITY	3	3	5	1	1	2	9	8	9	8
LONG. CROSS SECTION	0	0	4	1	1	4	1	0	1	0
TRANS.CROSS SECTION	0	1	1	1	1	4	1	1	0	0
BLANK TYPE	2	0	0	2	0	1	0	0	0	0
BLANK ORIENTATION	1	0	0	7	0	0	0	0	0	0
FLAKING TYPE OB.	5	5	5	5	8	6	5	0	8	0
FLAKING PATTERN OB.	1	1	1	1	8	1	1	0	1	0
FLAKING TYPE RE.	5	5	5	7	8	5	5	0	6	0
FLAKING PATTERN RE.	1	1	1	4	8	1	1	0	1	0
BLADE EDGE 1 SHAPE	0	0	2	1	1	2	1	1	0	0
BLADE EDGE 1 MORPH.	0	0	5	9	1	5	1	1	0	0
BLADE EDGE 2 SHAPE	0	2	2	1	5	1	9	0	0	0
BLADE EDGE 2 MORPH.	0	1	1	1	1	5	1	0	0	0
SHOULDER 1 SHAPE	1	1	4	4	4	4	3	4	3	0
SHOULDER 2 SHAPE	0	4	3	1	3	3	4	0	0	4
EDGE GRINDING	0	0	0	9	9	9	9	0	9	0
BASE SHAPE	2	3	0	2	1	3	3	3	3	0
BASAL THINNING	3	3	0	3	3	3	3	2	3	0
NOTCH 1 SHAPE	8	4	5	4	4	4	4	4	0	0
NOTCH 1 ORIENTATION	1	2	1	1	1	1	1	2	0	0
NOTCH 2 SHAPE	5	3	5	6	7	6	6	0	4	4
NOTCH 2 ORIENTATION	1	2	1	1	1	1	1	0	2	1
NOTCHING TECHNIQUE	5	5	3	3	3	1	4	0	3	0
PROX. LATERAL EDGE 1	8	8	3	3	6	4	0	8	0	0
PROX. LATERAL EDGE 2	6	3	3	3	1	7	8	0	4	1
TIP MORPHOLOGY	0	0	1	1	1	6	7	0	7	0
WEAR TYPE	0	0	0	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0	0	0	0
HEAT TREATMENT	7	1	0	3	0	0	0	0	0	0
FIGURE REFERENCE			77a	78n	76w	79p	77o			

AVONLEA

CATALOGUE NUMBER	63940	64557	65365	66088	66948	67053	67095	67172	67225	67363	69069
UNIT	44	45	45	45	46	46	46	46	46	46	47
LEVEL	1	2	2	3	3	2	3	1	2	2	1
DEPTH	10	20	20	30	30	20	30	10	20	20	10
CLASS	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE
RAW MATERIAL	SRC	SRC	CHERT	QTZITE	S.WOOD	S.SILT.	CHAL.	OBS.	SRC	CHERT	QTZITE
SOURCE			MAD.FM.								
POINT VARIETY		TIMB.RID	TIMB.RID	TIMB.RID	TIMB.RID.		TIMB.RID.		TIMB.RID	TIMB.RID.	
WEIGHT(gms)	0.1	0.4	0.8	0.4	0.4	0.2	0.4	0.2	0.4	0.7	0.3
MAXIMUM LENGTH	7.0	14.6	20.7	12.3	16.0	12.1	15.7	6.2	14.4	23.7	14.9
MAXIMUM WIDTH		11.1	14.6		10.9	9.4	13.0		11.8	11.8	10.7
POS. MAX. WIDTH		4.8	1.5		1.4	1.7			1.3	6.1	1.8
MAXIMUM THICKNESS	2.1	2.4	2.7	2.7	2.4	1.9	2.4		3.1	2.7	2.3
POS. MAX. THICKNESS		3.5	10.1	6.3	4.4	3.4	6.2		6.8	11.1	6.6
BLADE LENGTH					12.8	7.8				18.6	10.4
STEM LENGTH		4.8	5.7	3.6	3.2	4.3	4.2		4.2	4.7	5.1
BLADE WIDTH		11.1	14.6		10.5	8.8	11.0		10.0	11.8	8.9
SHOULDER WIDTH		11.1	14.5		10.5	8.8	11.0		10.0	11.8	8.9
POSITION SHOULDER		4.8	5.6		5.5	4.8	5.0		4.2	6.1	5.1
NECK WIDTH		9.0	10.4	9.5	9.0	7.3	9.8	8.6	9.4	9.9	8.1
POSITION NECK		3.8	4.9	3.1	3.9	2.9	3.1	3.3	3.5	3.3	3.2
STEM WIDTH			14.5		10.8	9.4	12.2		11.0	10.1	10.6
BASE WIDTH			13.5		10.3	8.9	13.0		11.6	10.4	9.5
BASAL NOTCH DEPTH			1.5		1.0					0.8	
NOTCH 1 DEPTH		0.9	1.9		0.6	1.0	1.0		0.6	0.4	0.9
NOTCH 1 BREADTH		3.0	3.1		2.2	2.1	3.0		2.5	4.6	2.5
NOTCH 2 DEPTH	1.0		1.8		1.1	0.9	1.3		0.3	1.0	0.9
NOTCH 2 BREADTH	3.0		3.1		2.8	2.9	2.4		1.5	1.9	3.2
PROX.LAT.EDGE 1 HT.		2.5	2.8		2.3	2.1		3.1	2.5	0.7	2.8
PROX.LAT.EDGE 2 HT.			3.1	1.9	2.1	2.2	2.2			2.6	2.5
TIP ANGLE					70	75				65	60
BLADE ANGLE					50	55	55		40	40	40
EDGE 1 ANGLE		35	25	40	35	35	40		55	25	45
EDGE 2 ANGLE		35	25	40	35	25	35		55	35	40
INTEGRITY	4	9	3	9	1	1	2	4	2	1	1
LONG. CROSS SECTION	0	2	2	0	1	2	1	0	1	1	2
TRANS.CROSS SECTION	0	1	1	1	1	2	1	2	1	1	1
BLANK TYPE	0	0	0	0	0	0	0	0	0	0	0
BLANK ORIENTATION	0	0	0	0	0	0	0	0	0	0	0
FLAKING TYPE OB.	0	5	1	5	5	5	5	0	8	8	8
FLAKING PATTERN OB.	0	1	2	1	1	1	3	0	8	8	8
FLAKING TYPE RE.	0	5	1	5	5	5	5	0	8	1	8
FLAKING PATTERN RE.	0	4	1	1	3	1	3	0	8	3	8
BLADE EDGE 1 SHAPE	0	2	1	0	2	1	1	0	1	2	2
BLADE EDGE 1 MORPH.	0	1	1	0	1	1	1	0	1	1	1
BLADE EDGE 2 SHAPE	0	2	1	0	2	1	1	0	1	2	1
BLADE EDGE 2 MORPH.	0	1	1	0	1	1	1	0	1	1	1
SHOULDER 1 SHAPE	0	4	1	1	4	6	4	0	3	4	4
SHOULDER 2 SHAPE	4	1	1	0	3	3	4	2	4	3	3
EDGE GRINDING	0	9	1	2	1	9	9	2	9	9	9
BASE SHAPE	0	3	3	1	5	1	1	1	3	8	8
BASAL THINNING	0	3	6	5	4	3	3	3	2	2	3
NOTCH 1 SHAPE	0	3	2	0	6	3	6	0	4	6	3
NOTCH 1 ORIENTATION	0	1	1	0	1	1	1	0	1	1	1
NOTCH 2 SHAPE	4	0	2	4	3	4	3	0	6	3	3
NOTCH 2 ORIENTATION	2	0	1	1	1	1	1	0	1	1	1
NOTCHING TECHNIQUE	0	0	4	5	5	4	3	1	5	5	5
PROX. LATERAL EDGE 1	0	2	3	0	2	1	5	1	7	5	3
PROX. LATERAL EDGE 2	7	0	3	3	2	3	2	0	5	2	7
TIP MORPHOLOGY	0	5	7	4	1	1	4	0	6	1	1
WEAR TYPE	0	0	0	0	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0	0	0	0	0
HEAT TREATMENT	0	0	0	9	3	0	9	0	9	7	0
FIGURE REFERENCE		76v	79v	79y	79q	78o	79z				79r

AVONLEA

CATALOGUE NUMBER	69652	69923	69924	74624	75314	75321	75468	77136	77814	78138	78308
UNIT	47	47	47	49	49	49	49	50	50	50	50
LEVEL	2	2	2	2	3	3	3	2	3	4	4
DEPTH	20	20	20	20	30	30	30	25	30	40	40
CLASS	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE
RAW MATERIAL	CHERT	S.SILT.	CHERT	QTZITE	S.MUD.	S.LIME.	SRC	PORC.	CHERT	CHERT	SRC
SOURCE	MAD.FM.									MAD.FM.	
POINT VARIETY	TIMB.RID.	TIMB.RID	TIMB.RID	TIMB.RID	TIMB.RID	TIMB.RID	TIMB.RID	HSI	TIMB.RID	TIMB.RID	TIMB.RID
WEIGHT(gms)	0.5	0.5	0.3	0.4	0.4	0.4	0.7	0.5	0.5	0.4	0.3
MAXIMUM LENGTH	14.6	12.0	12.6	12.7	14.1	10.7	14.6	21.8	11.9	15.6	10.9
MAXIMUM WIDTH		12.5	11.3	10.4	12.6	13.0	15.0	13.3	12.6	10.6	
POS. MAX. WIDTH				1.0	1.6	6.8	6.7	4.5	0.9	4.0	
MAXIMUM THICKNESS	2.4	2.9	2.0	2.5	2.9			2.0	3.0	2.8	2.0
POS. MAX. THICKNESS	9.9	5.2	11.4	5.2	4.9			13.5	4.5	6.2	
BLADE LENGTH								17.3			
STEM LENGTH			4.2	3.5	5.0	5.9	6.7	4.5	3.9	4.0	
BLADE WIDTH			10.3	9.4	10.4	6.8	15.0	13.3	11.2	10.6	
SHOULDER WIDTH			10.3	9.4	10.4	12.7	15.0	13.3	11.2	10.6	10.5
POSITION SHOULDER			4.2	3.5	5.0	5.9	6.7	4.5	3.9	4.0	
NECK WIDTH	9.5	9.9	8.4	9.3	9.9	9.9	11.4	7.7	10.4	8.0	9.3
POSITION NECK	3.3	3.7	2.6	2.5	3.3	4.3	4.1	4.1	2.6	3.6	
STEM WIDTH		11.0	11.1	10.4	12.5	12.7	14.2	11.3	12.2	9.4	
BASE WIDTH		12.5	11.3	9.6	11.3	9.6	13.2	9.4	12.3	8.3	
BASAL NOTCH DEPTH			0.6		1.7	1.8	1.5			0.7	
NOTCH 1 DEPTH		1.1	1.2	0.6	0.8	1.9	1.4	2.5	0.9	0.9	1.0
NOTCH 1 BREADTH		3.7	3.1	1.6	2.0	3.0	4.2	1.9	1.6	2.2	2.1
NOTCH 2 DEPTH	1.6	1.1	1.0	0.5	1.1	1.6	1.8	2.5	0.8	1.2	
NOTCH 2 BREADTH	3.0	3.1	2.4	1.9	1.8	2.8	3.7	2.1	1.7	2.3	
PROX.LAT.EDGE 1 HT.			1.9	1.4	2.0	3.0	2.4	1.9	1.7	2.4	1.9
PROX.LAT.EDGE 2 HT.		2.2	1.8	1.0	2.5	2.8	2.1	3.3	3.3	2.4	
TIP ANGLE								75			
BLADE ANGLE				30	40			40	40	45	
EDGE 1 ANGLE	30	50	30	60	45			25	45	45	
EDGE 2 ANGLE	30	40	30	60	50			25	45	40	
INTEGRITY	9	2	2	2	2	3	3	1	2	2	9
LONG. CROSS SECTION	2	1	2	1	1	0	0	4	1	2	0
TRANS.CROSS SECTION	1	1	2	1	1	1	1	9	1	1	1
BLANK TYPE	0	0	0	0	1	0	0	0	0	0	0
BLANK ORIENTATION	0	0	0	0	0	0	0	0	0	0	0
FLAKING TYPE OB.	5	8	8	8	1	5	8	6	5	5	0
FLAKING PATTERN OB.	2	8	8	8	3	1	8	1	1	1	1
FLAKING TYPE RE.	5	8	8	8	5	5	8	5	5	5	0
FLAKING PATTERN RE.	2	8	8	8	1	1	8	4	1	1	1
BLADE EDGE 1 SHAPE	0	9	1	1	2	0	0	2	2	2	0
BLADE EDGE 1 MORPH.	1	9	1	1	1	0	0	5	1	1	0
BLADE EDGE 2 SHAPE	0	9	1	2	2	0	0	2	1	2	0
BLADE EDGE 2 MORPH.	1	9	1	1	1	0	0	5	1	1	0
SHOULDER 1 SHAPE	0	8	2	3	4	3	4	5	4	4	4
SHOULDER 2 SHAPE	3	1	1	3	3	4	4	5	4	3	0
EDGE GRINDING	9	1	0	9	6	1	2	9	1	0	0
BASE SHAPE	0	1	3	1	3	3	3	1	1	3	0
BASAL THINNING	3	3	3	3	3	3	3	3	3	3	0
NOTCH 1 SHAPE	0	6	4	6	6	5	6	2	4	8	7
NOTCH 1 ORIENTATION	0	1	1	1	1	1	1	1	1	3	1
NOTCH 2 SHAPE	7	6	4	6	4	8	4	2	3	4	0
NOTCH 2 ORIENTATION	1	1	1	1	1	1	1	1	1	3	0
NOTCHING TECHNIQUE	0	3	4	5	5	3	1	3	2	5	0
PROX. LATERAL EDGE 1	0	5	2	1	3	3	1	4	1	3	8
PROX. LATERAL EDGE 2	0	8	2	2	3	3	1	1	2	8	0
TIP MORPHOLOGY	5	4	9	4	0	0	0	1	4	4	4
WEAR TYPE	0	0	0	0	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0	0	0	0	0
HEAT TREATMENT	2	0	9	0	0	0	0	0	0	2	0
FIGURE REFERENCE	79x	77m	76u		77q	79w	76y	77r	77n		

	AVONLEA	TRIANGULAR								
CATALOGUE NUMBER	78556	61567	61867	61868	62607	62608	63107	63108	63123	63669
UNIT	50	41	44	44	44	44	44	44	44	44
LEVEL	4	3	3	3	3	3	2	2	3	3
DEPTH	40	30	30	30	30	30	20	20	30	30
CLASS	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE
RAW MATERIAL	S.WOOD	CHERT	CHERT	S. LIME	S. LIME	S. LIME	S. WOOD	QTZITE	SRC	CHERT
SOURCE										
POINT VARIETY	TIMB.RID.									
WEIGHT(gms)	0.3	0.6	0.5	0.4	0.8	0.6	0.8	0.6	0.5	0.7
MAXIMUM LENGTH	12.7	12.4	17.3	9.1	18.4	14.7	20.7	13	12.6	18.5
MAXIMUM WIDTH			12.8			15	10.9			
POS. MAX. WIDTH			4.3		4.5	4	3			
MAXIMUM THICKNESS	2.2		2.8		3.1	2.7	4			3.6
POS. MAX. THICKNESS	7.5		5.6		8.2	10.9	7.7			5.4
BLADE LENGTH	8.6									
STEM LENGTH	3.9									
BLADE WIDTH	9.9									
SHOULDER WIDTH	9.9									
POSITION SHOULDER	3.9									
NECK WIDTH	8.9									
POSITION NECK	2.9									
STEM WIDTH										
BASE WIDTH						14.7				
BASAL NOTCH DEPTH										
NOTCH 1 DEPTH										
NOTCH 1 BREADTH										
NOTCH 2 DEPTH	0.7									
NOTCH 2 BREADTH	2.5									
PROX.LAT.EDGE 1 HT.										
PROX.LAT.EDGE 2 HT.	2.7									
TIP ANGLE	70		65				50			95
BLADE ANGLE	35									
EDGE 1 ANGLE	40		30		35	40	50	30		40
EDGE 2 ANGLE	45		30		35	30	45	35	35	35
INTEGRITY	5	4	1	4	9	2	1	2	2	5
LONG. CROSS SECTION	3	1	1	0	1	1	6	6	0	3
TRANS.CROSS SECTION	3	0	6	0	1	0	5	6	0	4
BLANK TYPE	4	0	0	0	0	0	0	0	4	0
BLANK ORIENTATION	0	0	0	0	0	0	0	0	0	0
FLAKING TYPE OB.	5	0	5	0	5	5	5	8	8	5
FLAKING PATTERN OB.	1	0	1	0	2	0	2	8	8	8
FLAKING TYPE RE.	5	0	5	0	5	5	5	8	8	5
FLAKING PATTERN RE.	1	0	1	0	2	0	2	8	8	4
BLADE EDGE 1 SHAPE	1	0	5	0	1	0	2	0	0	2
BLADE EDGE 1 MORPH.	1	0	2	0	2	0	2	0	0	2
BLADE EDGE 2 SHAPE	1	0	5	0	2	0	2	0	0	2
BLADE EDGE 2 MORPH.	1	0	2	0	2	0	2	0	0	5
SHOULDER 1 SHAPE	4	0	0	0	0	0	0	0	0	0
SHOULDER 2 SHAPE	4	0	0	0	0	0	0	0	0	0
EDGE GRINDING	9	9	0	0	0	0	0	0	0	0
BASE SHAPE	1	1	3	1	0	8	2	1	1	0
BASAL THINNING	3	3	3	0	0	3	2	0	3	0
NOTCH 1 SHAPE	9	0	0	0	0	0	0	0	0	0
NOTCH 1 ORIENTATION	9	0	0	0	0	0	0	0	0	0
NOTCH 2 SHAPE	6	0	0	0	0	0	0	0	0	0
NOTCH 2 ORIENTATION	1	0	0	0	0	0	0	0	0	0
NOTCHING TECHNIQUE	9	0	0	0	0	0	0	0	0	0
PROX. LATERAL EDGE 1	0	0	0	0	0	0	0	0	0	0
PROX. LATERAL EDGE 2	8	0	0	0	0	0	0	0	0	0
TIP MORPHOLOGY	1	5	1	0	7	7	2	7	5	1
WEAR TYPE	0	0	0	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0	0	0	0
HEAT TREATMENT	0	0	0	1	0	0	0	0	0	0
FIGURE REFERENCE		79s	79l			79t	77i			

TRIANGULAR

CATALOGUE NUMBER	63765	63766	63767	65601	65604	65897	66242	66244	66682	66812	67361
UNIT	44	44	44	45	45	45	45	45	46	46	46
LEVEL	2	2	2	2	2	2	1	1	2	2	2
DEPTH	20	20	20	20	20	20	10	10	20	20	20
CLASS	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	MURL	BIFACE	BIFACE	BIFACE
RAW MATERIAL	SRC	S. SILT	QTZITE	S. SILT	SRC	SRC	OBS.	KRF	CHERT	PORC.	SRC
SOURCE											
POINT VARIETY											
WEIGHT(gms)	0.5	0.4	0.4	0.7	0.5	0.4	0.8	0.2	1	0.7	0.2
MAXIMUM LENGTH	16.6	14.3	15	12.2	10.7	13.3	14.2	11.7	15.6	12.4	11.9
MAXIMUM WIDTH		12.6	10.8			10.9		10.7	16.6		
POS. MAX. WIDTH		0.6	1.6			1.4		0	2.4		
MAXIMUM THICKNESS		2.2	2.3	4.1		2.9			4.1		2.1
POS. MAX. THICKNESS		7.8	5.6	8.6		5.2			5.5		
BLADF LENGTH											
STEM LENGTH											
BLADE WIDTH						10.9		10.7	16.6		
SHOULDER WIDTH											
POSITION SHOULDER											
NECK WIDTH											
POSITION NECK											
STEM WIDTH									16.6		
BASE WIDTH	11	11.6	9.8		15.6	10.5	15.2	10.7	15.2		
BASAL NOTCH DEPTH											
NOTCH 1 DEPTH											
NOTCH 1 BREADTH											
NOTCH 2 DEPTH											
NOTCH 2 BREADTH											
PROX.LAT.EDGE 1 HT.					6.8						
PROX.LAT.EDGE 2 HT.											
TIP ANGLE		100	60								
BLADE ANGLE											
EDGE 1 ANGLE		35	40						40		
EDGE 2 ANGLE		35	45						35		
INTEGRITY	8	1	1	4	4	2	4	2	2	4	0
LONG. CROSS SECTION	1	1	4	0	0	0	0	0	0	0	0
TRANS.CROSS SECTION	0	1	4	0	1	1	1	0	1	1	0
BLANK TYPE	0	0	0	0	1	0	0	2	0	0	0
BLANK ORIENTATION	0	0	0	0	0	0	0	0	0	0	0
FLAKING TYPE OB.	0	8	8	0	0	5	0	6	5	0	0
FLAKING PATTERN OB.	0	8	8	0	0	1	0	1	1	0	0
FLAKING TYPE RE.	0	8	8	0	0	5	0	6	5	0	0
FLAKING PATTERN RE.	0	8	8	0	0	1	0	1	1	0	0
BLADE EDGE 1 SHAPE	0	2	2	0	0	1	0	1	5	0	0
BLADE EDGE 1 MORPH.	1	2	2	0	0	1	1	1	1	0	0
BLADE EDGE 2 SHAPE	0	2	6	0	0	9	0	1	3	0	0
BLADE EDGE 2 MORPH.	0	1	5	0	0	1	0	1	1	0	0
SHOULDER 1 SHAPE	0	0	0	0	0	0	0	0	0	0	0
SHOULDER 2 SHAPE	0	0	0	0	0	0	0	0	0	0	0
EDGE GRINDING	0	0	0	0	0	9	0	9	9	0	0
BASE SHAPE	3	3	3	0	1	1	1	1	8	1	0
BASAL THINNING	0	0	0	0	6	3	6	3	2	3	0
NOTCH 1 SHAPE	0	0	0	0	0	0	0	0	0	0	0
NOTCH 1 ORIENTATION	0	0	0	0	0	0	0	0	0	0	0
NOTCH 2 SHAPE	0	0	0	0	0	0	0	0	0	0	0
NOTCH 2 ORIENTATION	0	0	0	0	0	0	0	0	0	0	0
NOTCHING TECHNIQUE	0	0	0	0	0	0	0	0	0	0	0
PROX. LATERAL EDGE 1	0	0	0	0	1	4	4	4	6	4	0
PROX. LATERAL EDGE 2	0	0	0	0	0	4	4	4	4	0	0
TIP MORPHOLOGY	7	1	1	0	0	8	0	5	5	0	0
WEAR TYPE	0	0	0	0	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0	0	0	0	0
HEAT TREATMENT	0	0	0	0	9	9	0	7	7	0	0
FIGURE REFERENCE		77h	79e		79k						

TRIANGULAR

CATALOGUE NUMBER	67654	67664	67819	68025	68412	68440	69885	70143	70803	71739	72014
UNIT	46	46	46	46	46	46	47	47	47	44	43
LEVEL	2	3	2	2	2	1	1	2	1		2
DEPTH	20	30	20	20	20	10	10	20	10		35
CLASS	MURL	BIFACE	BIFACE	MURL	BIFACE	BIFACE	MURL	MURL	BIFACE	BIFACE	BIFACE
RAW MATERIAL	QTZITE	S. LIME	CHAL.	CHERT	CHERT	QTZITE	PORC.	CHERT	SRC	S. LIME	CHERT
SOURCE					MAD. FM.						
POINT VARIETY											
WEIGHT(gms)	0.6	0.5	0.4	0.3	0.2	2	0.4	0.5	0.4	0.4	0.7
MAXIMUM LENGTH	16.4	15.1	10.5	10.9	9	27.1	13.9	13.3	13.3	19.3	18.7
MAXIMUM WIDTH			12.1	12.3		14.2	13.8	11.2		11	12.7
POS. MAX. WIDTH			1.7	0		2	2.8	3.6		0	6.1
MAXIMUM THICKNESS	2.5	2.6				4.9	2.4	3.1	2.9	2.1	3.4
POS. MAX. THICKNESS	10.1	6.5				6.9	3.6	7.6	6.2	10.4	6.7
BLADE LENGTH	16.4					27.1	13.9	13.3			
STEM LENGTH											
BLADE WIDTH				12.3		14.2	13.8	11.2		11	12.7
SHOULDER WIDTH											
POSITION SHOULDER											
NECK WIDTH											
POSITION NECK											
STEM WIDTH											
BASE WIDTH		11.7	11.2	12.3	14	10.3	11.1	10.2		11	6.7
BASAL NOTCH DEPTH						1				0.3	
NOTCH 1 DEPTH											
NOTCH 1 BREADTH											
NOTCH 2 DEPTH											
NOTCH 2 BREADTH											
PROX.LAT.EDGE 1 HT.											
PROX.LAT.EDGE 2 HT.											
TIP ANGLE							95	100		60	80
BLADE ANGLE						20	55	45	35	35	45
EDGE 1 ANGLE		40		25		55	65	65	40	30	40
EDGE 2 ANGLE	25			45		65	40	50	35	30	40
INTEGRITY	3	3	4	3	4	2	1	1	3	1	1
LONG. CROSS SECTION	2	0	0	0	0	1	2	3	1	2	1
TRANS.CROSS SECTION	0	1	8	1	1	1	2	1	1	2	1
BLANK TYPE	2	0	0	1	0	0	0	0	0	0	0
BLANK ORIENTATION	2	0	0	6	0	0	0	0	0	0	0
FLAKING TYPE OB.	6	1	5	6	0	6	6	6	8	8	8
FLAKING PATTERN OB.	1	0	1	1	0	1	1	1	8	8	4
FLAKING TYPE RE.	6	6	5	6	0	6	6	6	8	8	8
FLAKING PATTERN RE.	1	0	1	1	0	1	1	1	8	8	4
BLADE EDGE 1 SHAPE	0	2	0	0	0	1	9	1	1	2	1
BLADE EDGE 1 MORPH.	0	1	0	0	0	1	9	4	1	1	1
BLADE EDGE 2 SHAPE	6	0	0	1	0	9	9	2	1	2	5
BLADE EDGE 2 MORPH.	1	0	1	1	0	1	9	5	1	1	1
SHOULDER 1 SHAPE	0	9	0	0	0	9	9	9	9	9	9
SHOULDER 2 SHAPE	0	9	0	0	0	9	9	9	9	9	9
EDGE GRINDING	0	9	0	0	0	9	8	9	9	9	9
BASE SHAPE	1	1	1	1	1	3	2	1	1	3	1
BASAL THINNING	3	3	3	3	6	3	9	3	3	3	4
NOTCH 1 SHAPE	0	0	0	9	0	9	9	9	9	9	9
NOTCH 1 ORIENTATION	0	0	0	9	0	9	9	9	9	9	9
NOTCH 2 SHAPE	0	0	0	9	0	9	9	9	9	9	9
NOTCH 2 ORIENTATION	0	0	0	9	0	9	9	9	9	9	9
NOTCHING TECHNIQUE	0	0	0	9	0	9	9	9	9	9	9
PROX. LATERAL EDGE 1	0	6	4	4	4	9	9	4	0	4	6
PROX. LATERAL EDGE 2	0	6	4	4	4	4	9	4	4	4	6
TIP MORPHOLOGY	8	0	0	0	0	4	9	1	4	1	1
WEAR TYPE	0	0	0	0	0	1	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	3	0	0	0	0	0
HEAT TREATMENT	0	3	1	1	3	0	9	1	2	0	0
FIGURE REFERENCE		77g								76l	

TRIANGULAR

CATALOGUE NUMBER	72054	73072	73107	73915	74951	75220	75419	75831	75868	75955	76910
UNIT	43	4	4	49	49	49	49	49	49	50	50
LEVEL	2	2	2	1	2	2	3	4	4	1	2
DEPTH	40	20	20	10	20	20	30	40	40	18	24
CLASS	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE
RAW MATERIAL	CHERT	CHERT	CHERT	S. PEAT	OBS.	CHERT	SRC	SRC	SRC	PORC.	QTZITE
SOURCE	MAD. FM.	MAD. FM.	TOW								
POINT VARIETY					TOY						
WEIGHT(gms)	0.4	0.4	0.3	1.6	0.2	0.6	0.8	0.8	0.7	0.6	1.4
MAXIMUM LENGTH	15.7	13.7	13.8	27.3	12.2	18.6	14.3	21.3	16.3	12.4	20.9
MAXIMUM WIDTH	10.7		10.6								13.4
POS. MAX. WIDTH	1.4		0.8								9.5
MAXIMUM THICKNESS	2.7		2.2		2.5			2.7	3.9		5.5
POS. MAX. THICKNESS	4.4		5.1		4.2			10.3	8		8.2
BLADE LENGTH				27.3	6.4						
STEM LENGTH					6						
BLADE WIDTH	10.7		10.6		7.7						
SHOULDER WIDTH					7.7						
POSITION SHOULDER					6						
NECK WIDTH					7.3						
POSITION NECK					4.9						
STEM WIDTH											
BASE WIDTH	10.2	11.8	8.6	9.4							
BASAL NOTCH DEPTH		0.6	0.6								
NOTCH 1 DEPTH					0.4						
NOTCH 1 BREADTH					2.5						
NOTCH 2 DEPTH					0.6						
NOTCH 2 BREADTH					3						
PROX.LAT.EDGE 1 HT.					2.3						
PROX.LAT.EDGE 2 HT.											
TIP ANGLE	60		70	70	70	95		65			
BLADE ANGLE	45		40		30	25	40	40	35		20
EDGE 1 ANGLE	45		25		50	40	45	45	65		50
EDGE 2 ANGLE	50	30	40		45		55	55	55		45
INTEGRITY	1	3	1	0	5	9	3	5	9	4	9
LONG. CROSS SECTION	2	0	2	1	1	9	0	1	6	0	1
TRANS.CROSS SECTION	4	2	2	1	1	4	1	1	6	0	1
BLANK TYPE	0	0	0	0	0	1	0	0	0	0	0
BLANK ORIENTATION	0	0	0	0	0	4	0	0	0	0	0
FLAKING TYPE OB.	6	0	8	0	5	5	8	5	8	0	8
FLAKING PATTERN OB.	1	0	8	0	1	1	8	1	8	0	8
FLAKING TYPE RE.	6	0	8	0	5	5	8	5	5	0	8
FLAKING PATTERN RE.	1	0	8	0	1	1	8	1	1	0	8
BLADE EDGE 1 SHAPE	2	0	2	0	2	2	0	2	1	0	1
BLADE EDGE 1 MORPH.	5	0	1	0	5	5	4	1	4	0	1
BLADE EDGE 2 SHAPE	9	2	2	0	3	0	0	2	2	0	1
BLADE EDGE 2 MORPH.	1	1	1	0	1	0	4	1	4	0	1
SHOULDER 1 SHAPE	9	9	9	9	3	0	9	9	0	0	9
SHOULDER 2 SHAPE	9	9	9	9	3	0	9	9	0	0	9
EDGE GRINDING	1	9	9	9	9	0	9	9	0	0	9
BASE SHAPE	1	8	3	1	1	0	1	1	0	0	1
BASAL THINNING	2	5	3	3	3	0	3	6	7	0	0
NOTCH 1 SHAPE	9	9	9	9	6	0	9	9	0	0	9
NOTCH 1 ORIENTATION	9	9	9	9	1	0	9	9	0	0	9
NOTCH 2 SHAPE	9	9	9	9	8	0	9	9	0	0	9
NOTCH 2 ORIENTATION	9	9	9	9	1	0	9	9	0	0	9
NOTCHING TECHNIQUE	9	9	9	9	3	0	9	9	0	0	9
PROX. LATERAL EDGE 1	4	4	4	0	1	0	9	0	0	0	4
PROX. LATERAL EDGE 2	4	4	4	0	0	0	9	0	0	0	0
TIP MORPHOLOGY	1	0	1	1	1	2	0	1	4	0	5
WEAR TYPE	0	0	0	0	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0	0	0	0	0
HEAT TREATMENT	0	0	0	0	0	4	0	0	0	0	0
FIGURE REFERENCE								76s			

	TRIANGULAR						SMALL STEMMED	
CATALOGUE NUMBER	77582	77583	77745	78456	78555	78863	70631	74246
UNIT	50	50	50	50	50	50	47	49
LEVEL	3	3	3	4	4	6	2	2
DEPTH	30	35	34	40	49	66	20	20
CLASS	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	MURL	MURL
RAW MATERIAL	SRC	S. LIME	SRC	SRC	SRC	SRC	CHERT	S.SILT
SOURCE								
POINT VARIETY								TOY
WEIGHT(gms)	0.4	0.7	0.7	0.4	0.6	3	0.5	0.1
MAXIMUM LENGTH	15.5	19.8	16.3	13	16	31.1	16.4	10.9
MAXIMUM WIDTH	11.1			10.5	12.9	18.7	9.7	6.7
POS. MAX. WIDTH	2.6			2	2.8	5	5.4	3.8
MAXIMUM THICKNESS	2.4			2.7	3.2	5.3	3.6	1.7
POS. MAX. THICKNESS	5.5			4.3	5.7	12.4	4.9	2.1
BLADE LENGTH						31.1		7.3
STEM LENGTH							4.8	3.6
BLADE WIDTH				10.5	12.9	18.7	9.7	6.7
SHOULDER WIDTH							9.7	6.7
POSITION SHOULDER							5.4	3.6
NECK WIDTH								
POSITION NECK								
STEM WIDTH								
BASE WIDTH	9.4			9.5	8.3	12.6	7	3.1
BASAL NOTCH DEPTH								
NOTCH 1 DEPTH								
NOTCH 1 BREADTH								
NOTCH 2 DEPTH							0.9	
NOTCH 2 BREADTH							3.7	
PROX.LAT.EDGE 1 HT.								
PROX.LAT.EDGE 2 HT.								
TIP ANGLE	65				85	55		65
BLADE ANGLE	35	25		35	40	20	40	35
EDGE 1 ANGLE	25	25		65	40	65	45	30
EDGE 2 ANGLE	35	25	30	50	55	65	50	50
INTEGRITY	1	9	9	2	1	0	2	1
LONG. CROSS SECTION	2	2	0	1	1	1	6	2
TRANS.CROSS SECTION	2	2	1	1	8	1	1	2
BLANK TYPE	1	0	0	0	0	0	0	0
BLANK ORIENTATION	6	0	0	0	0	0	0	0
FLAKING TYPE OB.	8	1	8	8	8	8	6	9
FLAKING PATTERN OB.	8	2	8	8	8	8	1	9
FLAKING TYPE RE.	8	1	8	8	8	8	6	6
FLAKING PATTERN RE.	8	2	8	8	8	8	1	1
BLADE EDGE 1 SHAPE	2	1	0	1	2	2	2	2
BLADE EDGE 1 MORPH.	1	1	0	1	1	1	4	4
BLADE EDGE 2 SHAPE	2	1	1	1	9	1	2	3
BLADE EDGE 2 MORPH.	1	1	1	1	9	1	4	4
SHOULDER 1 SHAPE	0	9	9	9	9	9	9	3
SHOULDER 2 SHAPE	0	9	9	9	9	9	3	3
EDGE GRINDING	9	9	9	9	9	9	1	9
BASE SHAPE	1	3	0	1	1	1	1	1
BASAL THINNING	3	6	0	0	2	3	3	1
NOTCH 1 SHAPE	9	9	9	9	9	9	9	9
NOTCH 1 ORIENTATION	9	9	9	9	9	9	9	9
NOTCH 2 SHAPE	9	9	9	9	9	9	6	9
NOTCH 2 ORIENTATION	9	9	9	9	9	9	1	9
NOTCHING TECHNIQUE	9	9	9	9	9	9	6	9
PROX. LATERAL EDGE 1	6	0	0	9	4	0	4	9
PROX. LATERAL EDGE 2	6	4	4	9	6	0	5	9
TIP MORPHOLOGY	1	7	0	5	1	1	4	1
WEAR TYPE	0	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0	0
HEAT TREATMENT	0	0	0	0	0	0	0	0
FIGURE REFERENCE	76r	79u				81f	79d	78h

BESANT

CATALOGUE NUMBER	61262	61469	61611	61613	61646	62419	65512	66181	67531	67904	68409
UNIT	41	41	41	41	42	44	45	45	46	46	46
LEVEL	4	2	5	5	1	2	3	3	3	2	2
DEPTH	40	20	50	50	50	20	30	30	30	20	20
CLASS	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE
RAW MATERIAL	S.WOOD	CHERT	S.LIME	KRF	CHERT	S.MUD.	SRC	S.MUD.	KRF	KRF	CHERT
SOURCE					MAD.FM.						
POINT VARIETY	TYPE 1	TYPE 2	TYPE 2	TYPE 1	TYPE 2	TYPE 2	TYPE 2	TYPE 1	TYPE 1	TYPE 1	TYPE 1
WEIGHT(gms)	1.2	1.4	2.3	0.2	1.3	0.3	1.9	1.7	0.8	0.4	0.4
MAXIMUM LENGTH	19.2	18.0	24.7	8.9	20.5	18.6	17.4	23.8	9.0	8.9	7.0
MAXIMUM WIDTH	14.2	15.4			15.8		19.8				
POS. MAX. WIDTH	2.5	11.5			3.7	10.6	9.4				
MAXIMUM THICKNESS	4.9				4.3						
POS. MAX. THICKNESS	8.3				11.0	5.5					
BLADE LENGTH	12.6							15.8			
STEM LENGTH	6.6	10.0	7.9		9.7	7.5	9.4	8.0			
BLADE WIDTH	13.1	15.8			9.4		19.8				
SHOULDER WIDTH	12.9	15.5	16.9		9.2	15.4	19.8				
POSITION SHOULDER	6.7	10.0	9.6		9.6	8.2	9.4				
NECK WIDTH	11.3	11.8	13.8		11.1	10.4	14.8		13.7	13.6	
POSITION NECK	4.6	6.5	6.4		6.4	6.5	6.2	5.4	4.3	4.6	
STEM WIDTH	14.2	14.8	16.9		15.8	14.0	16.0		17.1		
BASE WIDTH	13.0	10.7	14.8		14.7	14.0	14.1		14.8	14.6	
BASAL NOTCH DEPTH									0.9		0.9
NOTCH 1 DEPTH	1.1	1.4	1.8		2.0	2.0	1.5				
NOTCH 1 BREADTH	4.8	3.9	4.0		4.7	4.7	4.9				
NOTCH 2 DEPTH	1.1	1.9	1.7		1.8	2.4	1.6				
NOTCH 2 BREADTH	4.0	4.9	4.9		4.5	4.6	5.8				
PROX.LAT.EDGE 1 HT.			1.5		1.4		1.9		3.2	2.1	4.4
PROX.LAT.EDGE 2 HT.	1.9	5.5	3.0				26.0		2.7	2.6	
TIP ANGLE								95			
BLADE ANGLE											
EDGE 1 ANGLE	55	50			45						
EDGE 2 ANGLE	50				40						
INTEGRITY	1	3	3	4	9	2	3	8	4	4	4
LONG. CROSS SECTION	3	1	1	0	5	1	0	0	0	0	0
TRANS.CROSS SECTION	3	0	1	0	3	0	1	0	1	0	0
BLANK TYPE	0	4	0	0	0	0	4	0	0	0	0
BLANK ORIENTATION	0	0	0	0	0	0	0	0	0	0	0
FLAKING TYPE OB.	5	0	8	0	7	0	0	0	0	0	0
FLAKING PATTERN OB.	1	0	8	0	4	0	0	0	0	0	0
FLAKING TYPE RE.	5	0	8	0	5	0	0	5	0	0	0
FLAKING PATTERN RE.	1	0	8	0	2	0	0	1	0	0	0
BLADE EDGE 1 SHAPE	9	0	0	0	0	0	0	2	0	0	0
BLADE EDGE 1 MORPH.	1	0	0	0	2	0	0	0	0	0	0
BLADE EDGE 2 SHAPE	9	0	0	0	0	0	0	0	0	0	0
BLADE EDGE 2 MORPH.	1	0	0	0	2	0	0	0	0	0	0
SHOULDER 1 SHAPE	3	4	4	0	3	3	2	0	0	0	0
SHOULDER 2 SHAPE	3	4	4	0	3	3	2	0	0	0	0
EDGE GRINDING	1	1	2	0	1	9	1	0	0	2	1
BASE SHAPE	1	1	1	1	1	2	2	0	3	1	3
BASAL THINNING	2	3	2	0	3	3	3	0	6	6	4
NOTCH 1 SHAPE	6	8	4	0	4	4	4	0	0	0	0
NOTCH 1 ORIENTATION	1	1	1	0	1	2	1	0	0	0	0
NOTCH 2 SHAPE	4	4	4	0	4	4	4	0	0	0	0
NOTCH 2 ORIENTATION	1	1	1	0	1	2	1	0	0	0	0
NOTCHING TECHNIQUE	2	1	3	0	5	2	3	0	0	0	0
PROX. LATERAL EDGE 1	0	0	8	0	6	6	6	0	8	4	3
PROX. LATERAL EDGE 2	1	9	8	4	0	6	6	0	8	4	0
TIP MORPHOLOGY	3	5	0	0	6	5	4	1	0	0	0
WEAR TYPE	0	0	0	0	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0	0	0	0	0
HEAT TREATMENT	0	0	0	0	0	0	4	4	3	3	2
FIGURE REFERENCE	80d		81g		80i	80j	81h	80e	80c		

	BESANT				PELICAN LAKE		PINTO/ELKO EARED
CATALOGUE NUMBER	71871	72447	72965	73240	61033	68441	75466
UNIT	43	4	4	4	40	46	49
LEVEL	1	2	2	2	1	1	3
DEPTH	30	20	20	20	50	10	30
CLASS	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE
RAW MATERIAL	S.MUD.	OBS.	ARG.	OBS.	SRC	CHERT	CHERT
SOURCE			KTNY				
POINT VARIETY	TYPE 2						
WEIGHT(gms)	1.3	1	1.6	0.1	0.8	0.8	0.6
MAXIMUM LENGTH	23.2	10.5	21.5	6.8	7.5	14.0	9.5
MAXIMUM WIDTH			15.5				
POS. MAX. WIDTH			7.1				
MAXIMUM THICKNESS	4.5		4.8				
POS. MAX. THICKNESS	8.4		9.2				
BLADE LENGTH	14.5						
STEM LENGTH	8.7		7.1			6.6	
BLADE WIDTH	13.6		15.5				
SHOULDER WIDTH	13.6		15.5				
POSITION SHOULDER	8.1		7.1				
NECK WIDTH	9.5	14.4	11.4		14.0	10.5	
POSITION NECK	6.3	6.1	5.5		6.0	5.1	
STEM WIDTH		17.4	13.6		18.9		
BASE WIDTH			13.7		18.7		14.6
BASAL NOTCH DEPTH							3.4
NOTCH 1 DEPTH	2.1		1.7				
NOTCH 1 BREADTH	5.3		4.2				
NOTCH 2 DEPTH			1.5				
NOTCH 2 BREADTH			4.8				
PROX.LAT.EDGE 1 HT.	3.0	2.9	2				
PROX.LAT.EDGE 2 HT.			2.5				
TIP ANGLE	50						
BLADE ANGLE	50		40				
EDGE 1 ANGLE	50		45				
EDGE 2 ANGLE	60		55				
INTEGRITY	5	4	2	4	4	9	2
LONG. CROSS SECTION	3	0	9	0	0	0	0
TRANS.CROSS SECTION	3	1	1	0	0	1	1
BLANK TYPE	0	0	0	0	0	0	0
BLANK ORIENTATION	0	0	0	0	0	0	0
FLAKING TYPE OB.	5	0	8	0	0	5	0
FLAKING PATTERN OB.	1	0	8	0	0	1	0
FLAKING TYPE RE.	5	0	8	0	0	5	0
FLAKING PATTERN RE.	1	0	8	0	0	1	0
BLADE EDGE 1 SHAPE	1	0	2	0	0	0	0
BLADE EDGE 1 MORPH.	4	0	1	0	0	0	0
BLADE EDGE 2 SHAPE	1	0	1	0	0	0	0
BLADE EDGE 2 MORPH.	4	0	1	0	0	0	0
SHOULDER 1 SHAPE	2	0	1	0	0	0	0
SHOULDER 2 SHAPE	1	0	4	0	0	5	0
EDGE GRINDING	6	2	2	0	2	2	2
BASE SHAPE	2	2	2	0	2	2	4
BASAL THINNING	3	3	2	0	3	3	3
NOTCH 1 SHAPE	4	0	4	0	0	2	0
NOTCH 1 ORIENTATION	1	0	1	0	0	3	0
NOTCH 2 SHAPE	4	0	4	0	0	0	0
NOTCH 2 ORIENTATION	1	0	3	0	0	0	0
NOTCHING TECHNIQUE	1	0	3	0	3	3	0
PROX. LATERAL EDGE 1	8	4	4	0	4	4	0
PROX. LATERAL EDGE 2	0	0	4	6	4	0	0
TIP MORPHOLOGY	2	0	5	0	0	0	0
WEAR TYPE	0	0	0	0	0	0	0
WEAR LOCATION	0	0	0	0	0	0	0
HEAT TREATMENT	0	0	0	0	0	9	0
FIGURE REFERENCE	80h				81l	80g	80a

	NORTHERN SIDENOTCHED		OXBOW/LEWIS		LANCEOLATE		
CATALOGUE NUMBER	61001	70481	61006	61031	65435	66542	75732
UNIT	39	47	39	40	45	46	49
LEVEL		2		1	3	2	4
DEPTH		20		50	30	20	40
CLASS	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE	BIFACE
RAW MATERIAL	SRC	CHERT	QTZITE	CHERT	SRC	SRC	CHERT
SOURCE							
POINT VARIETY							
WEIGHT(gms)	2.1	1.2	3.9	4.7	2.1	0.8	2.1
MAXIMUM LENGTH	23.4	14.1	36.1	34.5	30.7	20.3	15.5
MAXIMUM WIDTH	18.7	16.5	20.7				
POS. MAX. WIDTH	3.0	8.0	11.9				
MAXIMUM THICKNESS	4.8		5.3	6.5	4.5		
POS. MAX. THICKNESS	13.6		18.1		10.3		
BLADE LENGTH			25.9				
STEM LENGTH	9.9	8.0	10.2				
BLADE WIDTH	16.9		20.7				
SHOULDER WIDTH	16.9		20.7				
POSITION SHOULDER	10.0	8.0	9.8				
NECK WIDTH	13.0	11.5	15.3				
POSITION NECK	8.0	5.6	16.7				
STEM WIDTH	18.7	15.7					
BASE WIDTH	15.8	14.4					
BASAL NOTCH DEPTH							
NOTCH 1 DEPTH	2.5	2.3					
NOTCH 1 BREADTH	4.7	4.2					
NOTCH 2 DEPTH	2.3	1.9	2.0	2.3			
NOTCH 2 BREADTH	3.1	3.6	6.1	6.5			
PROX.LAT.EDGE 1 HT.		4.6					
PROX.LAT.EDGE 2 HT.	5.9	4.1	3.4	4.4			
TIP ANGLE			100		65	75	
BLADE ANGLE							
EDGE 1 ANGLE	40		50		50		
EDGE 2 ANGLE	50		40	45	60	40	
INTEGRITY	2	3	5	3	5	5	4
LONG. CROSS SECTION	1	0	1	0	3	0	0
TRANS.CROSS SECTION	0	1	1	0	1	0	0
BLANK TYPE	0	0	0	0	0	0	0
BLANK ORIENTATION	0	0	0	0	0	0	0
FLAKING TYPE OB.	0	0	8	0	5	0	0
FLAKING PATTERN OB.	0	0	8	0	1	0	0
FLAKING TYPE RE.	0	0	8	0	5	0	0
FLAKING PATTERN RE.	0	0	8	0	1	0	0
BLADE EDGE 1 SHAPE	1	0	6	0	2	0	0
BLADE EDGE 1 MORPH.	1	0	1	0	1	0	0
BLADE EDGE 2 SHAPE	1	0	2	5	2	2	0
BLADE EDGE 2 MORPH.	1	0	1	1	1	1	0
SHOULDER 1 SHAPE	0	2	0	0	0	0	0
SHOULDER 2 SHAPE	4	1	4	4	0	0	0
EDGE GRINDING	7	2	2	2	9	0	0
BASE SHAPE	3	1	3	3	3	0	0
BASAL THINNING	3	7	6	3	6	0	6
NOTCH 1 SHAPE	4	7	0	0	0	0	0
NOTCH 1 ORIENTATION	1	1	0	0	0	0	0
NOTCH 2 SHAPE	2	7	6	6	0	0	0
NOTCH 2 ORIENTATION	1	1	2	2	0	0	0
NOTCHING TECHNIQUE	5	1	3	0	0	0	0
PROX. LATERAL EDGE 1	4	1	0	0	4	0	0
PROX. LATERAL EDGE 2	1	8	7	7	0	0	0
TIP MORPHOLOGY	5	6	2	7	1	1	0
WEAR TYPE	2	0	0	0	0	0	0
WEAR LOCATION	1	0	0	0	0	0	0
HEAT TREATMENT	0	9	0	1	7	0	7
FIGURE REFERENCE	81c	80b	81a	81d	81b	81a	

	SHALLOW NOTCHED LANCEOLATE	MISCELLANEOUS DART POINT			
CATALOGUE NUMBER	65119	61962	63444	71592	71957
UNIT	45	44	44	999	43
LEVEL	4	3	3		1
DEPTH	40	30	30		30
CLASS	BIFACE	MURL	BIFACE	MURL	BIFACE
RAW MATERIAL	OBS.	S.MUD.	PORC.	PORC.	SRC
SOURCE					
POINT VARIETY					
WEIGHT(gms)	3.1	0.9	0.4	1.3	1.7
MAXIMUM LENGTH	22.1	10.8	9.9	13.9	23.5
MAXIMUM WIDTH	20.5				16.8
POS. MAX. WIDTH	8.6				5.4
MAXIMUM THICKNESS					4.2
POS. MAX. THICKNESS					8.4
BLADE LENGTH					
STEM LENGTH	8.9				
BLADE WIDTH					16.8
SHOULDER WIDTH					15.8
POSITION SHOULDER	8.6				5.4
NECK WIDTH	17.7	16.5			
POSITION NECK	5.3	8.0			
STEM WIDTH		19.3			
BASE WIDTH		18.1			
BASAL NOTCH DEPTH					
NOTCH 1 DEPTH					
NOTCH 1 BREADTH					
NOTCH 2 DEPTH	1.4				2.3
NOTCH 2 BREADTH	5.2				3.0
PROX.LAT.EDGE 1 HT.		2.3			
PROX.LAT.EDGE 2 HT.	3.4	3.5			2.2
TIP ANGLE					
BLADE ANGLE					
EDGE 1 ANGLE	45				40
EDGE 2 ANGLE	45				40
INTEGRITY	9	4	4	8	9
LONG. CROSS SECTION	0	0	0	0	2
TRANS.CROSS SECTION	1	0	0	0	1
BLANK TYPE	0	0	0	0	0
BLANK ORIENTATION	0	0	0	0	0
FLAKING TYPE OB.	5	0	0	0	8
FLAKING PATTERN OB.	1	0	0	0	8
FLAKING TYPE RE.	5	0	0	0	8
FLAKING PATTERN RE.	1	0	0	0	8
BLADE EDGE 1 SHAPE	0	0	0	0	0
BLADE EDGE 1 MORPH.	0	0	0	0	1
BLADE EDGE 2 SHAPE	0	0	0	0	0
BLADE EDGE 2 MORPH.	0	0	0	0	1
SHOULDER 1 SHAPE	3	0	0	5	0
SHOULDER 2 SHAPE	8	0	0	0	3
EDGE GRINDING	3	0	0	0	9
BASE SHAPE	1	8	2	0	2
BASAL THINNING	3	3	0	0	6
NOTCH 1 SHAPE	6	0	0	0	0
NOTCH 1 ORIENTATION	1	1	0	0	0
NOTCH 2 SHAPE	6	0	0	0	1
NOTCH 2 ORIENTATION	1	1	0	0	1
NOTCHING TECHNIQUE	4	5	0	0	0
PROX. LATERAL EDGE 1	0	8	0	0	0
PROX. LATERAL EDGE 2	4	0	6	0	8
TIP MORPHOLOGY	5	0	0	0	5
WEAR TYPE	0	0	0	0	1
WEAR LOCATION	0	0	0	0	2
HEAT TREATMENT	0	0	0	0	0
FIGURE REFERENCE	80f				81j

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